POWER PLANT ENGINEERING

GENERATION, TRANSMISSION AND UTILIZATION OF STEAM, ELECTRIC, DIESEL AND HYDRAULIC POWER

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Fourth Dimension Projectile

WHILE the munition makers of Europe have been working overtime making shells for the next war which, if one can believe the newspaper headlines, is not far off, Westinghouse on this side of the Atlantic has also been engaged in the manufacture of a shell—a projectile if you please. But this projectile, unlike the European variety, is one whose trajectory is destined to be described not in time but space; and time, if we accept a loose interpretation of the Einstein theory of relativity, may be called the "fourth" dimension. Hence this projectile is in effect a projectile for the fourth dimension. Westinghouse calls it a "Time Capsule." It is a Cupaloy cylinder, pointed at both ends as shown above and in the illustration on page 652 fitted with an inner pyrex glass envelope embedded in a water-proof mastic. Within this shell will be placed various things which will give the future inhabitants of our planet an idea of our civilization. This capsule will then be sunk in the soft earth beneath the Westinghouse Building at the New York World's Fair where, it is hoped, it may stay for the next 5000 years. A curious undertaking, isn't it? Perhaps a waste of time and money and yet probably as worth while as the making of shells with which to demolish Europe. There may be no trace left of Mr. Hitler's dreams of empire or of his empire or anything of Europe as we now know it and maybe even this organization known as the United States of America will have long perished from the earth when this shell is to be opened but none of these things probably will matter very much. Whether those who open the capsule will have any use for the gadgets of our time which they find in it probably also will not matter but if by chance we could leave something to tell them of our shortcomings, of our foolish and futile wars, of our mismanagement of the world—something of these matters, then, if this shell ever should be recovered perhaps this thing would be worth while; we may do them one important bit of service. But they probably would not understand, just as we fail to understand the records we find of our own past.

WITH THE EDITORS

Development of the Operating Staff

TO THE MEN in charge of operation belongs the responsibility for efficient and continuous operation of the equipment in the plant. Designers of equipment and plant arrangement, manufacturers, construction contractors and plant owners can do little more than set the stage for the operators to play upon. It is the operator who must live with the equipment days and weeks on end, keep it in adjustment through continuously changing load, weather, fuel and water conditions, and it must not be forgotten that it is upon the results secured by the engineers in charge of operation that the reputations of all designers, manufacturers, constructors and even the owners depend, for a plant is no better than the economy which it secures.

With such responsibility resting on the operating staff it behooves the plant management to secure, for the supervision of this work, men thoroughly familiar with all details of the equipment, its care and its operation, and then to authorize the development of an entire staff of operators to care for the equipment in the plant. It is essential not only to educate these men and keep them posted on the new applications of principles to the field, but it is of equal if not greater importance to develop the personal qualifications of individuals for the work which they are expected to do. The "know how" is only the foundation for any work, results are secured only through the application of knowledge to the physical manipulation of devices, and this physical manipulation in the operation of a power plant requires a type of character that is distinctive.

To a large extent, desirable operating qualifications can be developed but, like artists, there seem to be certain inherent characteristics that make a man an extremely efficient or a mediocre power plant operator. Incessant vigilance, continuous application of the senses to note slight changes in conditions, requires a mind that is the reverse of dreamy. At times, quick decisions and action are necessary, at others patience must be exerted to await the outcome of imposed conditions. Again, manual skill is a requirement for certain types of work and in all cases the operator must possess an instinctive desire not only to cooperate but also to coordinate his work with others, which is quite distinctive from the individualist who is continuously in mental rebellion.

Training an operating staff and keeping it thoroughly efficient and up to date is no small task but is the only way progress can be made in the field of power generation since this link in the chain cannot be short-circuited. Contributing his thoughts and helpful suggestions along this line, Vernald H. Davis, Plant Research Engineer for the Oklahoma Gas & Electric Co., has written an article for POWER PLANT ENGINEERING which is published on other pages of this issue under the title Power Plant Educational Program. The article is descriptive of a successful plan which could be profitably employed in many plants throughout the country.

Did The N.D.H.A. Start Something?

COMPANIES in eight cities submitted design data for a typical district heating problem proposed by the distribution committee of the N.D.H.A. A 12 in., 200 lb. line 400 ft. long in a hypothetical city block was covered by 20 problem specifications. Complete estimated prices varied from a minimum of $9,923 at Pittsburgh to a maximum of $17,805 at New York. Detroit, Lansing and Rochester come within 12 per cent of the Pittsburgh estimate; Philadelphia came about 21.5 per cent higher while Boston was a close second to New York with $15,723.

The problem was divided into three parts: steam line proper and manholes, with each part divided into three major cost divisions: trench work, structure, piping and insulation. Taking the minimum cost estimate of each of the 12 divisions gives a minimum cost of $7,973 as compared with a maximum of $20,094, over 250 per cent higher.

Specifications were not always adhered to strictly and supposedly each company followed its standard practice which has been found adequate in past service and can be justified for local reasons. It would seem, however, that when $100 will do a job in one city it would take some fast talking to justify $180, $250 and in some cases $750 for the same job in another city.

This condition is not confined to the district heating business, it probably represents conditions current in all phases of engineering. The N.D.H.A. deserves the commendation of the engineering profession for so emphatically pointing out the urgent need for setting up standards of practice. Some of the other engineering societies might help to justify their existence by setting up typical problems in their own field in an effort to determine what portion of the expense is necessary and how much is the result of precedence, personal idiosyncracies and misplaced emphasis on service. Lincoln service is nice but when competition is keen Ford transportation helps to cut the overhead.

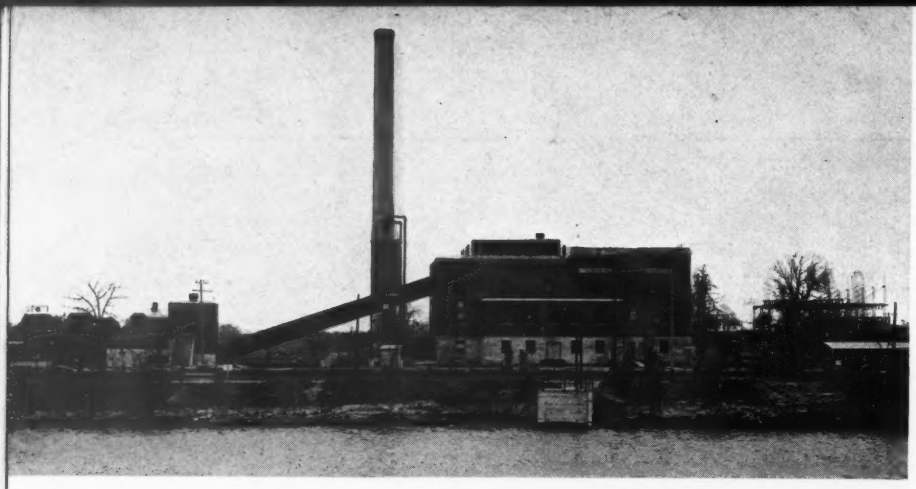


Fig. 1. Woodcock Station was named after Floyd W. Woodcock, president of both the Central Ohio Light & Power Co. and the parent company, Crescent Public Service Co. The first section with two 5000-kw. units will be completed by the first of the year.

450 lb., 825 deg. selected as most economical conditions for the new Woodcock Station of Central Ohio Light & Power Co. at Bluffton, O. Two 60,000-lb. per hr. boilers and one 5000-kw. turbine installed, with the second 5000-kw. turbine under construction and scheduled for completion by the end of the year

WOODCOCK STATION of the Central Ohio Light & Power Co. is one of those rare exceptions where the natural advantages of the plant site have been combined with good engineering to produce a station warranting close study by those interested in contemporary small plant design. It is: Located near the junction of the Nickel Plate and Northern Ohio Railroads; adjacent to existing transmission lines; near the geographical and load center of the system; has reliable rail connections with all the important coal fields; and a supply of cooling water which allows adequate provision for expansion in accordance with future load demands. More important to those interested in fuel economy, the design takes advantage of recent high temperature advances without getting into the pressure range that demands extensive use of alloy steels.

This company, a unit of the Crescent Public Service Co., Wilmington, Del., has headquarters at Findlay, O., and serves approximately 15,000 customers located in two unconnected areas in Ohio. The Western Division, whose power requirements will be supplied principally from the Woodcock plant by means of about 375 mi. of transmission and distribution lines extending from Lockington on the south, to Portage on the north and Jonestown on the west. Power is retailed to 30 communities and wholesaled to seven as well as to the Ohio Electric Power Co. through an interconnection at St. Mary's. The western division peak approximates 11,500 kw., and prior to this spring was carried by two generating stations supplemented by the purchase of some power from the Ohio Power Co. at So. Lima under a contract which expires Feb. 1, 1939. The Findlay Station has an installed capacity of 11,000 kw. but this is limited to an effective capacity of about 7000 kw. due to poor cooling water conditions. The St. Mary's Station contains a leased 4000-kw. turbine in connection with the power contract. It is contemplated to reduce the St. Mary's plant principally to a substation basis after Feb. 1, 1939. The Findlay plant will be continued as an operating and standby plant as it is also operated in connection with the hot water heating system in Findlay.

Studies of the factors involved indicated that the new station should have two 5000-kw. units in the initial section and that the most economic operating conditions would be with steam at 450 lb., 825 deg. F. These conditions take advantage of high temperatures so as to give a low heat rate, yet avoid high costs due to the extensive use of alloy steels. Using 450 lb., 750 deg. F. steam as a base, studies[1] showed that on the basis of the expected load factors and $4.00 coal, 450 lb., 825 deg. F. would cost about 1/6 more for the items affected by the higher steam temperature, or pay a return on the incremental investment approximately 6 times as great as, 650 lb., 825 deg. F. The cycle selected, with three stages of extraction heating, has a design heat rate at full load of 15,050 B.t.u. per kw-hr. sent out as indicated by the heat balance Fig. 4.

Plant Arrangement and Construction

Figure 1 is an exterior view of the station which consists of an outdoor switchyard, a main building of steel and brick construction, a coal crusher and conveyor house and a hoist tower for the drag scraper.

[1]An article dealing in detail with these studies is being prepared by G. A. Gaffert, Mechanical Engineer of Sargent & Lundy, Inc.

TABLE I. DIVISION OF STATION COSTS IN PER CENT AND APPROXIMATELY IN DOLLARS PER KILOWATT OF CAPACITY ON THE BASIS OF TWO GENERATING UNITS. The first section with one unit cost $852,000 and it is estimated the second unit will increase the cost to approximately $1,050,000.

Land and land improvements	2.03
Site improvements, including track, fence, etc.	0.94
Main building substructure	1.04
Main building steel	1.92
Main building superstructure	5.09
Telephones and lighting	0.76
Circulating water system	2.78
Coal handling equipment	3.36
Boilers and accessories	10.50
Draft system	1.16
Fuel system	3.57
Feedwater system	1.97
Piping system	5.53
Ash handling system	0.94
Miscellaneous steel and iron	1.05
Turbine and accessories	23.00
Condensing equipment	5.85
Main electrical equipment	3.95
Auxiliary electrical equipment	3.17
Miscellaneous power plant equipment	0.19
Substation equipment	7.67
Miscellaneous construction expense	1.92
Engineering fees and general supervision	11.71
	100.00

Economy With Medium Pressure-High Temperature

Foundation conditions are ideal and the 6 ft. overburden at this point was removed, leaving natural limestone bedrock to form the basement floor. Foundations for the building are of reinforced concrete anchored to the bedrock and topped with a 9 ft. reinforced base course.

With such careful planning and ideal conditions it is not surprising, therefore, that the station went up with little delay. The preliminary survey started on June 15; excavation on July 13; first concrete was poured on Aug. 10; structural steel erection was started Oct. 13; boiler erection was started Nov. 10; the condenser was unloaded Jan. 20; the turbine arrived Feb. 21 and was first operated Mar. 8; both boilers were ready for service Mar. 26; and the plant was put in operation April 1. It was put on the line immediately in order to provide economy, but various adjustments have since been made to meet conditions developed under regular operation. Work is now under way on the second turbine unit and it will be ready for service by the first of the year.

In a country where good cooling water supplies are at a premium advantage was taken of an abandoned quarry which forms a spring fed lake, covering about half of the 53 acre plant site. This lake is about 20 ft. deep except for a 3 acre L shaped area about 50 ft. deep near the western end. The bed of the lake is even and a covered trench 6 ft. wide and 4 ft. deep extends from the screen chamber at the shore, 870 ft. into the lake and terminates in a 5 ft. 8 in. diam. copper bearing pipe, 25 ft. long, which drops at a sharp angle down to the deep section.

From the screen chamber a tunnel, 6 ft. high and 10 ft. wide, extends 370 ft. under the power house, with one shaft rising in the present building to supply the two units and a second shaft, just north of the building, for a future extension. The tunnel is divided by a vertical masonry wall and acts as both the intake and discharge. At the screen chamber stop logs in the discharge side serve as a submerged weir to discharge the warm water at the surface so that it must travel almost 900 ft. horizontally and 50 ft. vertically to get back to the intake.

From the limited data available it is felt that the lake is adequate for a capacity of somewhere between 15,000 and 20,000 kw. without spraying. Readings taken during the hot summer weather show that the temperature is uniform throughout the lake to a level just below the bottom of the intake pipe. Below this it drops about 20 deg. Complete data being collected systematically will eventually serve as a valuable guide in calculating the natural cooling capacity of ponds and lakes, a matter which heretofore has received so little study that it is practically non existent in engineering literature.

Excluding a two story office and store room section on the south side, 14 ft. 6 in. wide by 54 ft. 6 in. long, the main building is 107 by 62 ft. 6 in. with an average height of about 50 ft. No curtain wall has been provided and the two boilers face the turbines, although separated from them by a 30 ft. open auxiliary bay. The ground level has been made the operating floor and on it are located all boiler auxiliaries, the main switchboard and both the turbine and boiler gage boards. Turbines are set on islands, 12 ft. higher but provision has been made for extension throttles so that they may be started from either level.

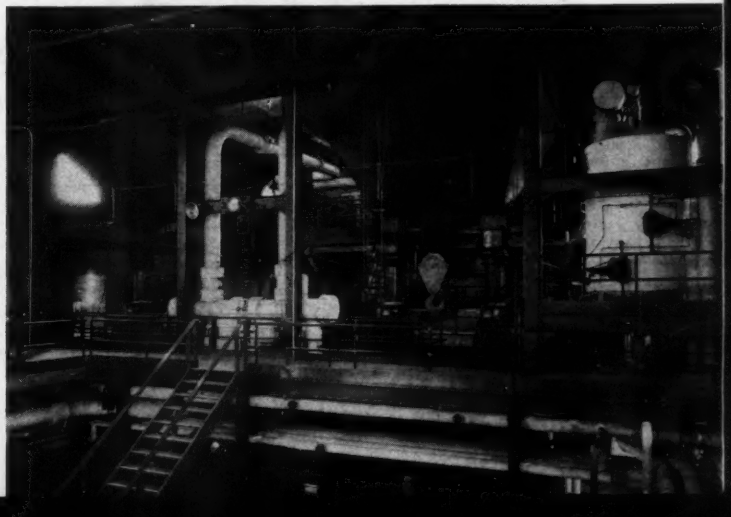


Fig. 2. View from the auxiliary switchboard gallery. The deaerating heater is on the extreme right and the turbine on the same level at the extreme left with only part of the throttle valve showing. The operating floor with both boiler and turbine control panels and main switchboard is on the lower level. Pulverizers are on the same floor under the gallery, driving motors for two of them being visible just to the right of the panels. The stairway at the left is temporary and will be replaced with a permanent one as soon as the second unit is installed in the immediate foreground

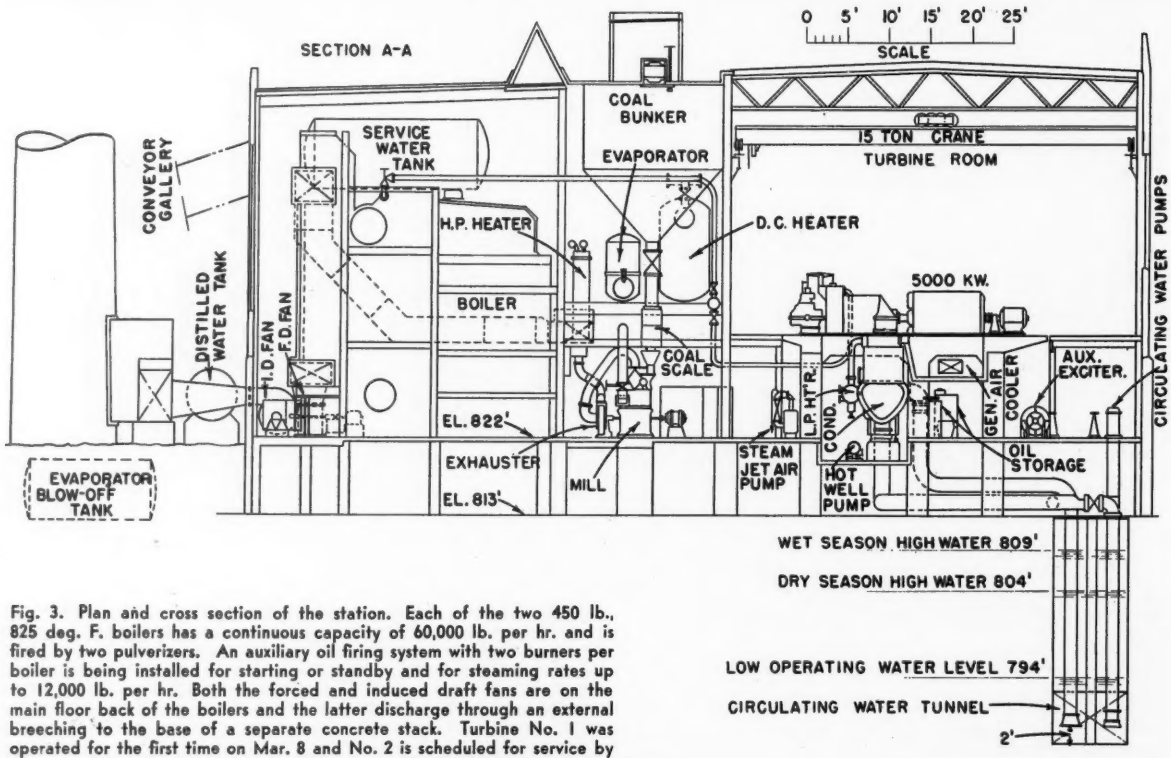
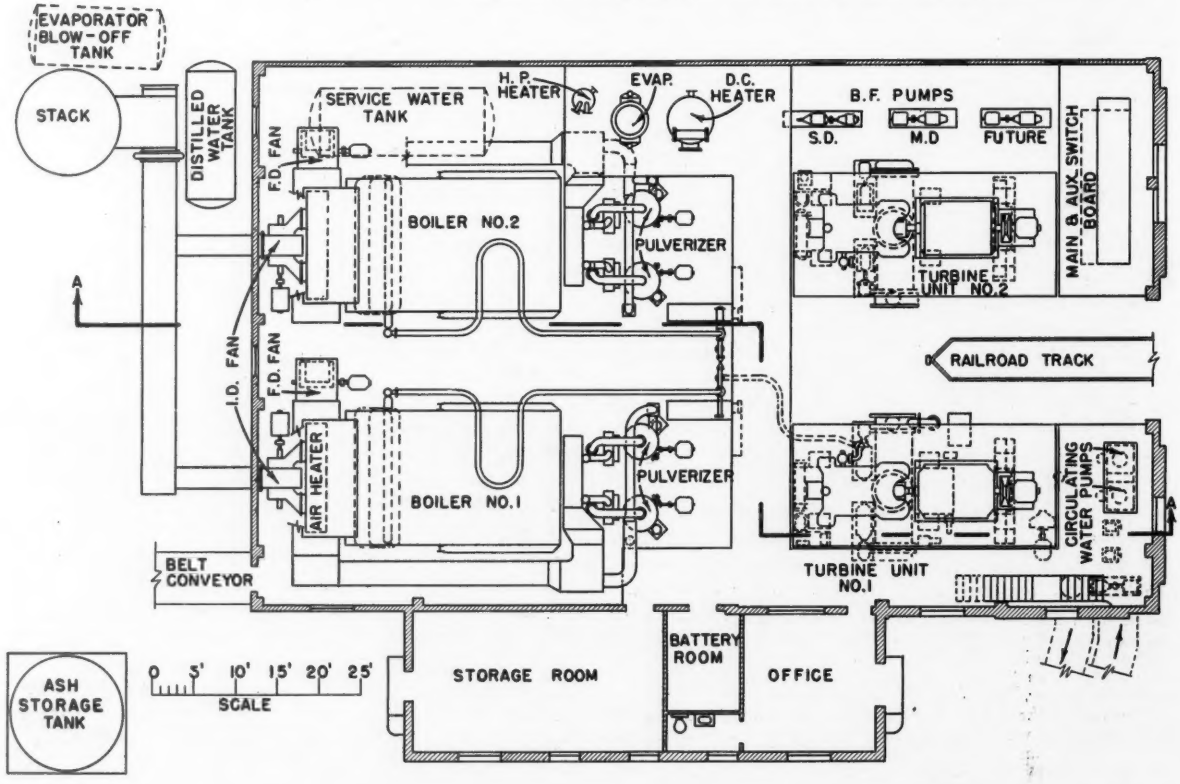


Fig. 3. Plan and cross section of the station. Each of the two 450 lb., 825 deg. F. boilers has a continuous capacity of 60,000 lb. per hr. and is fired by two pulverizers. An auxiliary oil firing system with two burners per boiler is being installed for starting or standby and for steaming rates up to 12,000 lb. per hr. Both the forced and induced draft fans are on the main floor back of the boilers and the latter discharge through an external breeching to the base of a separate concrete stack. Turbine No. 1 was operated for the first time on Mar. 8 and No. 2 is scheduled for service by the first of the year. Both units are rated at 5000 kw. and the generators are, or will be, connected direct to the 34.5 kv. bus through two 6000 kv-a. three phase transformers. Auxiliary power is taken from the same bus through two 750 kv-a. auxiliary three phase transformers, each of which supplies a separate bus with the auxiliaries split between them. Thus auxiliary power is always available whether the station is operating or not. A property plot is shown by Fig. 6. Cooling water taken from the deep section of an abandoned quarry, is brought to the plant by a tunnel built with a dividing wall so that it serves both as an intake and discharge. Coal storage and reclaiming is by means of a drag scraper. Inasmuch as no curtain wall is used between the boilers and turbines all coal conveyors, breakers, gates and scales are made dust tight



Plant Ratios

Total area per kw. capacity	0.8055 sq. ft.
Boiler room area per kw.	0.3738 sq. ft.
Turbine room area per kw.	0.3312 sq. ft.
Office sections area per kw.	0.1005 sq. ft.
Total volume per kw.	39.67 cu. ft.
Boiler room volume per kw.	19.67 cu. ft.
Turbine room volume per kw.	17.53 cu. ft.
Office sections volume per kw.	2.47 cu. ft.
Intake chamber volume per kw.	0.33 cu. ft.
Coal handling building volume per kw.	1.52 cu. ft.
Dirt excavation	3822 cu. yd.
Concrete used	1472.8 cu. yd.

Coal handling facilities consist of a series of Link-Belt conveyors with a capacity of 50 t. per hr. and a Sauerman drag scraper used for both storage and reclaiming. A separate building has been provided for the drag scraper hoist and the arrangement is such that coal is reclaimed directly to the same track hopper used for unloading cars. An inclined flight conveyor, supplied from the track hopper by a reciprocating feeder, discharges either to the initial storage pile or to an inclined belt conveyor which runs to the top of the boiler room. A crusher between these two conveyors can be bypassed or not depending upon the type of coal used. From the end of the belt conveyor a horizontal freight conveyor distributes the coal to the four 50 t. gunnite lined steel bunkers. From the bunkers the coal flows directly downward through Richardson scales to the mills. Because of the absence of a curtain wall all coal conveying equipment from the crusher house to the mills has been made dustproof.

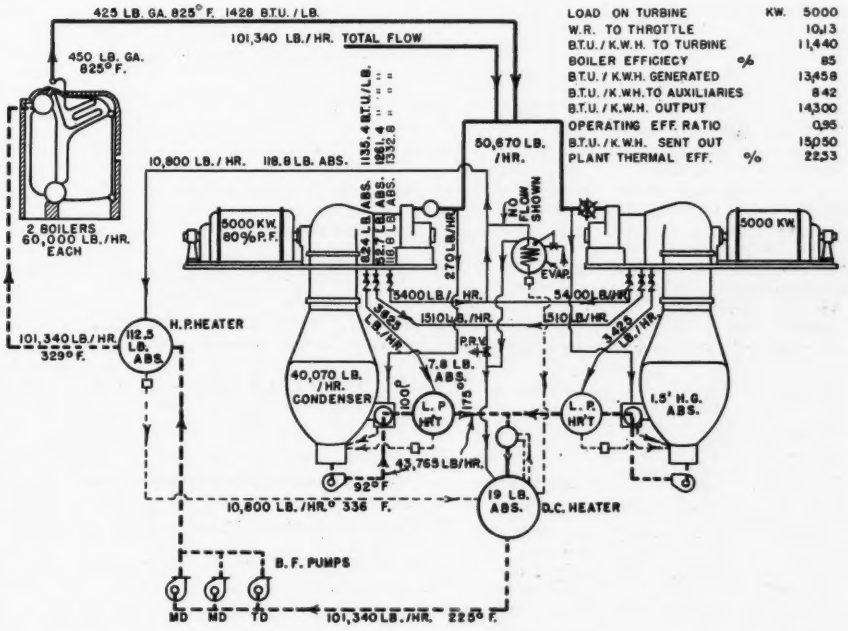


Fig. 4. Heat balance for full load. With industrial load predominating the peak load usually occurs on Tuesday, ironing day, and on Aug. 16 a maximum hourly generation of 600 kw. was carried with one boiler. Friday, Aug. 19, is, however, more typical of average conditions at present. The gross generation for 24 hr. was 111,700 kw-hr., of which the station used 8000 kw-hr. (7.17 per cent) leaving a net of 103,700 kw-hr. and a station heat rate of 15,220 gross or 16,400 net. Power factor, load factor and capacity factor averaged 81, 78.8 and 93.0 per cent respectively. Circulating inlet water was 84 deg. F. and the turbine exhaust back pressure 2.17 in. Final adjustments of the equipment and colder water during the winter are expected materially to improve the performance

Steam Generating Equipment

Two boilers of a special Riley three drum design with 6680 sq. ft. of heating surface and rated at 60,000 lb. per hr., 450 lb. ga., 825 deg. F. at the superheater outlet, are installed. Each boiler has a 1200 sq. ft. superheater, 6600 sq. ft., tubular air heater, Sturtevant forced and induced draft fan and two Flare-type burners. Both fans are on the main floor at the back of the boiler as shown by the plan and cross section, Fig. 3. Induced draft fans take their suction from the bottom of the air heater and discharge horizontally through an outdoor breeching to the base of a concrete chimney, 161 ft. high by 8 ft. I.D. at the top. The forced draft fan discharges up through the air heater to preheated air ducts which lead downward, diagonally and horizontally, to the burner windbox and mills. These C.E. bowl mills, two per boiler, each have a rated capacity of 3820 lb. of Eastern Kentucky coal per hour and are set on the main floor in front of their respective boilers. Furnaces have 1780 sq. ft. of water cooled surface and a volume of 3250 cu. ft. The heat release at 60,000 lb. per hr. is 24,500 B.t.u. per cu. ft. per hr.

Turbine Generator Units

Boilers face the turbine with their respective mills directly in front of, and screened from, the turbine foundations only by the boiler and turbine operating panels. The boilers have complete Askania combustion control, with individual boiler panels set parallel with, and on each side of, the 10-ft. aisle between the two units. The turbine panels are set at right angles to the boiler panels and face their respective units. This concentration of control makes it possible to operate the plant with one boiler operator, one turbine operator and one utility man per 6-hr. shift. These 12 men plus one maintenance man and the efficiency man on the day shift form the entire operating staff.

Main generating units (only one of which has been installed) consist of a 3600 r.p.m., 5000-kw. Westinghouse single shaft turbine designed for throttle conditions of 425 lb., 825 deg. F., and driving a 5000-kw.,

Woodcock Station List of Principal Equipment

Company, Central Ohio Light & Power Co.

Location, Bluffton, O.

Consulting Engineers, Sargent & Lundy, Inc.

Steam Generating Units—Riley Stoker Corp., 2—2 drum special boilers BBF No. 19 WW with a capacity of 60,000 lb. per hr., 450 lb. ga., 825 deg. F. at the superheater outlet. Heating surface 6680 sq. ft. plus 1780 sq. ft. of water cooled furnace walls. Furnace volume 3250 ft. Heat release at full load 24,500 B.t.u. per cu. ft. per hr. Superheater surface 1200 sq. ft. Vertical tubular air heater surface 6600 sq. ft. Fired by two flare type burners per boiler.

Coal Pulverizers—Combustion Engineering Co. 4 (2 per boiler). Individual grinding capacity 3820 lb. of Eastern Kentucky coal per hr. Mill and exhauster driven by a 60-hp. 1750 r.p.m. Allis-Chalmers motor. Feeder driven by a 1-hp., 1750 r.p.m. Allis-Chalmers motor.

Forced Draft Fan—B. F. Sturtevant Co.—2 Turbovane with capacity of 18,000 c.f.m. each at 8.0 in. and 100 deg. F. Each driven by 40-hp., 1750 r.p.m. Allis-Chalmers motor.

Induced Draft Fans—B. F. Sturtevant Co.—2 double width, double inlet with a rated capacity of 30,000 c.f.m. at 5.77 in. and 375 deg. F. gas. Each fan driven by a 60-hp., 1165 r.p.m. Allis-Chalmers motor.

Combustion Control—Askania Regulator Co. Complete oil and air operated system complete with two 16.8 g.p.m. oil pumps driven by 1½ hp. motors and four feed control blowers with Reeves drive and driven by ½-hp. motors.

Coal Handling System—Link-Belt Co. Capacity 50 t. per hr. consisting of a 30 in. reciprocating feeder driven by a 5 hp. motor; a 30-in. inclined flight conveyor driven by a 7½ hp. motor; an 18 in. inclined belt conveyor driven by a 5 hp. motor; and an 18 in. distributing flight conveyor over the bunkers driven by a 5-hp. motor.

Conveyor Belt—Quaker City Rubber Co.

Coal Crusher—United Iron Works. Capacity 30 t. per hr., driven by 20 hp., 1160 r.p.m. motor.

Coal Scales—Richardson Scale Co.—4 dust proof stationary type, each with Capacity 30 t. per hr., driven by 20-hp., ¼-hp. Master motors.

Coal Valves—Henry Pratt Co.—4 dustless type.

Drag Scraper—Sauerman Bros., Inc., outdoor drag scraper for coal storage and reclaiming, with 1 cu. yd. Crescent type bucket and a 40 hp. hoist motor.

Ash Handling Equipment—United Conveyor Corp. pneumatic "Nuveyor" with a multi-jet exhauster.

Track Hopper Bilge Pump—Yeomans Bros. 1 vertical with capacity of 75 g.p.m. against 60 ft. head driven by 3-hp., 1750 r.p.m. motor.

Ash Pit Doors—United Conveyor Corp.

Boiler Insulation—48 Insulations, Inc.

Chimney—General Concrete Construction Co., 161 ft. 1½ in. high, 8 ft. I-D at top.

Feedwater and Excess Pressure Regulators—Swartwout Co., S-C.

Fire Brick—Harbison-Walker Refractories Co.

Flues and Ducts—Terre Haute Boiler Works.

High Pressure Steam Traps—Armstrong Machine Works.

Non-Return, Atmospheric relief and high pressure check valves—The Edward Valve & Mfg. Co., Inc.

Piping System and Erection—Pittsburgh Piping & Equipment Co.

Piping and Duct Insulation—Johns-Manville.

Safety Valves—Crosby Steam Gage & Valve Co.

Soot Blowers—Diamond Power Specialty Corp.

Steel Grating—Art Iron & Wire Works, Inc.

Stop, Check and Drain Valves — The Edward Valve & Mfg. Co., Inc.

Tanks—Graver Tank & Mfg. Corp.—service water, distilled water, compressed air and gland water.

Tube Cleaners—Roto Co.

Water Columns and Gage Glass—Reliance Gauge Column Co.

Barometer, Vacuum Gage & Tachometer—Precision Thermometer & Instrument Co.

Boiler & Turbine Gage Boards—Askania Regulator Co.

Boiler Meter—Bailey Meter Co.

CO_2 Instruments—Hays Corp.

Cold Water Meter—Worthington Pump & Machinery Corp.

Condensate Venturi Meter — Simplex Valve & Meter Co.

Indicating Thermometer—C. J. Tagliabue Mfg. Co.

Multipoint Draft Gages—Ellison Draft Gage Co.

Multipoint Temperature Recorders—Brown Instrument Co.

Temperature and Pressure Recorders and Indicatitng Pressure Gages—Consolidated, Ashcroft, Hancock Division.

Test Gages and Tester—Crosby Steam Gage & Valve Co.

Turbo Generator—Westinghouse Electric & Mfg. Co. single shaft, 3600 r.p.m., 425 lb. ga., 825 deg. F. turbine driving a 5000 kw., 80 per cent p.f., 7200 v., 3 ph., 60 cycle generator, Y connected with the neutral grounded through disconnects. Main exciter rated at 40 kw., 125 v. shunt wound direct connected to the main generator. (Duplicate unit now being installed.)

Oil Cooler—Westinghouse Electric & Mfg. Co., vertical type, cooling surface 180 sq. ft., designed for 110 g.p.m. of 90 deg. water.

Generator Air Cooler — Westinghouse Electric & Mfg. Co., horizontal type with cooling surface 1790 sq. ft. designed for 150 g.p.m. of 90 deg. water.

Condenser—Ingersoll-Rand Co., horizontal, 2 pass condenser with surface of 4500 sq. ft. with external air cooler section. ¾ in. O.D. No. 18 B.W.G. arsenical copper tubes expanded at both ends.

Steam Jet Air Pump—Ingersoll-Rand Co., 2 stage twin element with an external air cooler built integral with inter and after condenser.

Turbine Oiling System—S. F. Bowser Co., Inc., complete with filter, oil precipitation tank and Viking transfer pumps.

Rubber Expansion Joints — Moisson Packing & Rubber Co.

Closed Heaters—The Whitlock Coil Pipe Co., 1—6-pass. horizontal low pressure heater with 188 sq. ft. of heating surface designed to heat 43,700 lb. per hr. from 100 to 176 deg. F. (to be duplicated on Unit No. 2). 1—4-pass vertical high pressure heater with 417 sq. ft. of heating surface designed to heat 101,340 lb. per hr. from 225 to 330 deg. F.

Deaerating Heater—Elliott Co.—1 vertical direct contact heater with capacity

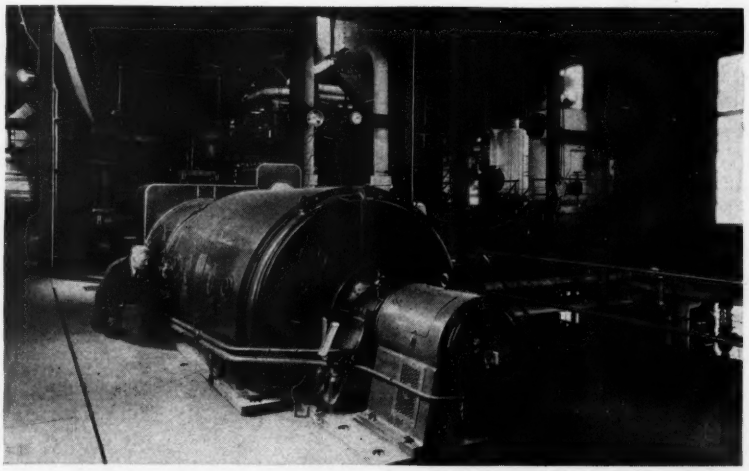


Fig. 5. Although both boiler and turbine operating panels are on the lower floor, provision has been made to start the turbine from there or from the turbine island. A second turbine is being installed on the right. In this picture Chief Engineer Ed Meckstroth poses for the photographer to show that the little windows in the generator casing have some use after all

of 135,000 lb. per hr., heated from 175 to 225 deg. F., complete with single pass vent condenser.

Evaporator—The Griscom-Russell Co., 1 single effect vertical evaporator with heating surface of 69 sq. ft. and a capacity of 4250 lb. per hr.

Domestic Hot Water Heater—Whitlock Coil Pipe Co.

Closed Heater Alarms—Davis Regulator Co.

Extraction Check Valves—Schutte & Koerting Co.

Liquid Level Controllers—Fisher Governor Co.

Boiler Feed Pumps—Worthington Pump & Machinery Corp., 2—6 stage horizontal centrifugals with capacity of 160 g.p.m. against total head of 1594 ft. One pump driven by a 125-hp., 425 lb. pressure, 5 lb. back pressure Terry turbine, the other by an Allis-Chalmers 125-hp., 3550 r.p.m. motor.

Circulating Water Pumps—Worthington Pump & Machinery Corp., 2 vertical single stage 16 in. Hiflo with capacity of 6900 g.p.m. against 35 ft. head and driven by 100-hp., 1165 r.p.m. Allis-Chalmers motors.

Hotwell Pumps — Ingersoll-Rand Co., 2—2 stage horizontal with capacity of 130 g.p.m. each against 115 ft. head, each driven by 15 hp., 1750 r.p.m. Allis-Chalmers motors.

Heating System Vacuum Pump—Nash Engineering Co., 1 Jennings No. 42 with capacity of 15,000 sq. ft. of equivalent direct radiation and driven by a 1½-hp., 1750 r.p.m. Continental motor.

Service Water Pumps—Worthington Pump & Machinery Corp., 2 single stage Monobloc with capacity of 260 g.p.m. each against 110 ft. head. Driven by 10-hp., 3520 r.p.m. motors.

Circulating Water Gate Valves and Piping, Standard gate valves and High pressure gate valves—Crane Co.

Air Compressor—Allis-Chalmers Mfg. Co., 1—2 stage rotary Ro-Twin with capacity of 112 c.f.m. against 80 lb. pressure and driven by a 30-hp., 1160 r.p.m. motor.

Reserve Air Compressor — Ingersoll-Rand Co., 1 single stage single cylinder with displacement of 6½ c.f.m., 80 lb. pressure. Driven by 1-hp. G. E. motor.

Stationary Screens—Simpson Steel Co.

Main Transformer — General Electric Co.—1 outdoor type, rated at 6000 kv-a., 7200 to 34,500, with high voltage neutral solidly grounded.

Main Switchboard — General Electric Co.—Made up of 6—90-in. high steel cubicles complete with instruments, synchronizing equipment, voltage regulators, test blocks, etc.

Auxiliary Switch Groups—I-T-E Circuit Breaker Co., flush mounted steel cubicles

Auxiliary Power Transformer—General Electric Co.—2 outdoor type, 34,500/480 v., 750 kv-a.

Lighting Transformer—2 General Electric Co., subway type, 37½ kv-a., 480/120/240 v.

Reserve Exciter—General Electric Co.—1—60-kw., 1200 r.p.m., 125 v., d.c., shunt wound generator, driven by a 100-hp. full voltage starting motor.

Lighting Cabinets—Square D Co., 4.

Lighting Fixtures—Westinghouse Electric & Mfg. Co.

Battery Charging Rectifier — General Electric Co.—Tungar.

Control Battery—Electric Storage Battery Co., 1—60-cell, 125 v., Exide for control and emergency lights.

Transformer Transfer Truck—Differential Steel Car Co.

Indoor Air Circuit Breakers and magnetic switches—I-T-E Circuit Breaker Co. Westinghouse Electric & Mfg. Co.

Potential and Current Transformer and Metering Equipment—General Electric Co.

Oil Circuit Breakers—General Electric Co., 4—600 amp., 34½ kv.

Field Switch Panel—General Electric Co. with two solenoid operated field switches.

Outdoor Disconnect Switches, air brake switches, fuse mountings and fuses—Railway & Industrial Engineering Co.

Lightning Arresters—General Electric Co., 9—Thyrite—Single pole outdoor type.

Cable—General Electric Co.

Insulators—Lapp Insulator Co.

0.80 p.f., 7200 v., 3 ph. 60 cycle generator and a 40-kw. direct connected exciter. The turbine exhausts to an Ingersoll-Rand 4500 sq. ft. two pass condenser with an external air cooler and a twin two stage steam jet air pump. The two motor driven hotwell pumps are located in a pit 2 ft. 9 in. below the main floor as shown by Fig. 3.

Circulating water is pumped by two Worthington vertical Hi-flo pumps with a capacity of 6900 g.p.m. each against a head of 31 ft. One pump is provided for each unit, but they are both installed over the vertical shaft in front of the No. 1 unit and cross-connected. Boiler feed pumps are also installed in the turbine room, on the main floor at the north side of No. 2 turbine foundation. Space has been provided for three units but only two are installed, (the third pump is being installed with the second turbine) both 3550 r.p.m. Worthingtons with a capacity of 160 g.p.m. against a head of 1594 ft. One is driven by an Allis-Chalmers motor, the other by a Terry steam turbine.

The main turbine is bled at three points for feedwater heating as shown by the heat balance diagram, Fig. 4. Low pressure heaters are located just under the turbine but the deaerating and high pressure heaters are located on the turbine gallery level near the boilers as shown by Fig. 2. A single stage evaporator, located between the two, takes steam from the high pressure bleed point and the deaerating heater acts as the evaporator condenser. Untreated quarry water is used as evaporator feed. Each unit has or will have an individual 188 sq. ft. Whitlock low pressure heater but the Elliott deaerating heater and Whitlock high pressure heater serve both turbines.

Generator leads are permanently connected with cable to the low side of a 6000-kv-a., 7200/34,500 v., General Electric 3 ph., transformer installed in the outdoor switchyard, and connected to the 34.5 kv. bus through 600-amp. oil circuit breakers. The present switchyard is sufficient to accommodate the output of two 5000-kw. units, and to provide for four 34.5-kv. outgoing feeder circuits, one 2.4-kv. local feeder and two auxiliary circuits. The bus can be cut in the center with one generator, two outgoing feeders and one auxiliary feeder connected to each half. The local feeder circuit can be connected to either section of the main bus. Auxiliary power is taken direct from the 34.5-kv. bus through two 750-kv-a., 34,500/480 v. 3 phase transformers, each of which has its own auxiliary bus. Auxiliaries are split between the two and the coal conveyors can be operated from either.

The main switchboard, located on the operating floor in the northeast corner, is of the General Electric duplex type with one cubicle per panel section. The present installation consists of six main panel sections and a swinging synchronizing panel. On the front of the switchboard is a mimic bus diagram of the 34.5-kv., 7.2-kv., 2.4-kv. and 480-v. circuits represented by copper, brass, copper enameled blue and nickel, respectively. Automatic load control is provided on one 34.5-kv. feeder circuit, the No. 1 circuit to St. Mary's.

All synchronizing is to the bus and the generator potential indicated on the synchronizing panel is in terms of the voltage on the high side of the transformer. Turbine governor control switches are provided at each feeder panel as well as at the turbine panel so that the unit may be synchronized from the most convenient point.

On the turbine gallery level, directly above the main switchboard, is the auxiliary switch group, consisting of an I-T-E eight panel switchboard three tiers high. Transformer and bus tie breakers are rated at 1200 amp. and have overload protection only. The

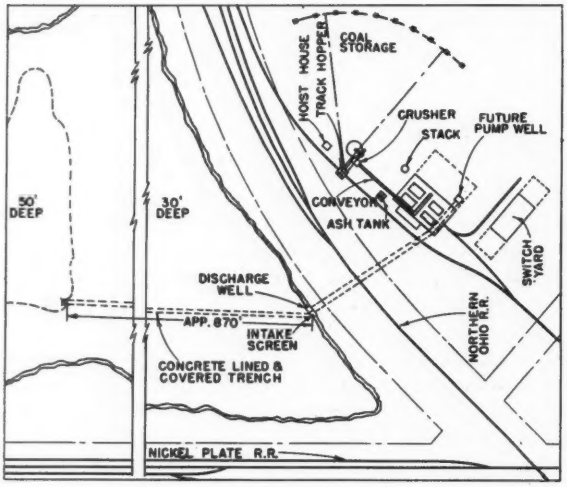


Fig. 6. Cooling water is taken from an abandoned quarry with the intake extending about 1000 ft. into the lake

100, 150 and 200 amp. feeder breakers have no overload protection. The controls are all located at some point convenient to the motor and provision was made for instantaneous short circuit protection only with the idea in mind that an operator would notice any considerable overload in time to change over to alternate equipment and thus avoid a forced outage.

With the exception of the crane motor, all 480-v. motors are of the squirrel cage full voltage starting type. Boiler auxiliary motors are interlocked so that they must be started and stopped in the proper order. The combustion control oil pump magnetic motor switches are interlocked so that if one opens the other closes automatically. No interlock is provided on the coal conveyors beyond that accomplished by tapping the motor supplies for the belt conveyor and the feeder on the motor side of the breakers feeding the distributing conveyor and inclined flight conveyor respectively.

Direct current for control circuits and emergency lights is provided by a 60 cell Exide storage battery, normally kept charged by a G. E. Tungar trickle charger, although the spare motor driven exciter can be used for charging in an emergency. This G. E. reserve exciter is on the main floor near the generator air cooler.

Power for lighting and miscellaneous uses is provided by two G. E. 37½-kv-a., single phase, 480/120-240 v., subway type transformers. Key lights in the system are connected to an automatic throw over switch which automatically connects them with the battery circuit in case of failure of the normal a.c. supply. Convenient outlets are provided at frequent intervals throughout the station. Recepticals and plugs are of the polarized type so that the frames of connected apparatus can be solidly grounded.

The grounding system in the station consists of a 3/16 by 1½ in. copper bus extending to all the buildings and connected to all apparatus requiring grounds, including the chimney with a driven ground at its base and the steel substation columns connected by steel reinforcing and wire mesh. The principal ground for the system is, however, a 500,000 c.m. cable laid in the intake tunnel and connected to the steel intake pipe.

The Central Ohio Light & Power Co. system, although comparatively small and serving a scattered area, boasts rates comparable with any section of the country, domestic rates ranging from 5 ct. per kw-hr. for the first 20 down in four steps to 2 ct. per kw-hr. for all over 150 kw-hr. Commercial and power rates are correspondingly low. The new station typifies the progressive spirit of the organization, every member of which is proud of the company's service, proud of the new station and the part that he personally played in the construction. To the following we are particularly indebted for data and information upon which the article is based: Frank C. Landers, Vice President and General Manager; Daniel Riedel, Supt. of Operation; John Sawvel, Asst. Supt. of Operation; Ed. Meckstroth, Chief Engineer; Paul Martinka, Efficiency Engineer; Robert Feeney, Electrical Engineer.

Carbon Gland Rings

CARBON GLANDS or seals are commonly used on steam turbine shafts and some factors of design and maintenance were outlined by N. L. Mochel of Westinghouse while speaking before the A. S. T. M.

Figure 1 shows the use of carbon-graphite rings for turbine glands. A combination of carbon material and steel shaft material that will give minimum wear is sometimes difficult to secure. Graphite rings that are quite soft will not wear the shaft rapidly, but show

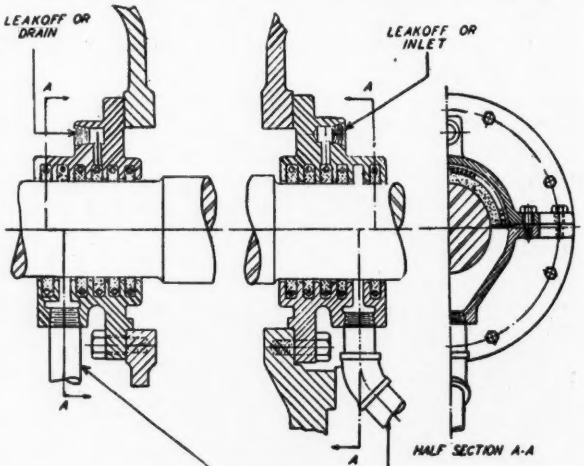


Fig. 1. Carbon gland packing

excessive wear themselves. If carbon rings of greater hardness are used, the shaft is often found to be scored or worn. When not operating, the presence of moisture between the carbon and the steel shaft often results in corrosion (pitting) of the shaft. Ordinary water appears to offer a strong electrolyte with two materials, such as iron and carbon, so far removed from each other in the galvanic table. A pitted shaft naturally results in greater ring wear. The use of renewable sleeves of hard stainless steel under the carbon, or of heavily chromium plating of the shaft at these points, improves wear conditions.

Power Plant Educational Program

Successful plant operation can be secured only when individuals on the operating staff are well informed and working together for the one purpose of service.

By VERALD H. DAVIS

Plant Research Engineer,
Riverbank Station,
Oklahoma Gas & Electric Co.,
Muskogee, Okla.

SHOULD an educational program be started in the plant?

An excellent way to arrive at the answer to this question, is to consider what a generating station is. Is it just a mass of iron, concrete, etc., moulded into machine and structure? A generating station is really a group of ideas, all working together for one purpose—service. It takes ideas to plan and manufacture the generators, the boilers and their auxiliaries. It takes other ideas to assemble this equipment into a power plant. It also takes ideas to operate this equipment after it is installed, and there is no better place to evolve these ideas than in a well planned educational program.

A successful educational program is a coöperative relation between employer and employe, mutually desired and mutually planned. The progressive employer, naturally, is ready to help his employes develop more alertness and efficiency. The interested employe, regardless of his position, desires to become as efficient and capable in that position as possible. He has the desire to be able to survey his years of service in the position he has filled, and to feel that he has been a good machinist, a good operator, a good oiler, or whatever the particular title happened to be.

To keep alert in any job requires study, a search for new ideas and new ways for doing things. This study and research, together with the opportunity for expression in group meetings, not only prepares an employe to handle his job better, but equips him with more poise and alertness to use in contacts with friends and in business or organization activities.

Essential Features of Program

Flexibility is a necessary characteristic of the educational program which should be planned according to the specific conditions encountered in each individual plant, depending upon the educational background of the men and the age and location of the plant.

The program can be planned a year at the time, or for a period of years. It is considered that an outline covering three or four years' work is most effective. A complete program includes instruction in essential grade school or academic fundamentals, such as mathematics, English, spelling and elementary thermodynamics, in addition to the discussions on the construction, operation and maintenance of the equipment installed in the plant. All of these secondary subjects cannot be properly mastered in one year and should be taken up in the order of the greatest local demand and need. All study should be woven around the primary subjects of operation and maintenance.

Each main course will consist of 12 to 16 meetings, held during the fall and winter months of each year, each meeting to be not more than 1 hr. and 15 min. in length. It has been found that interest is more likely to lag after 14 meetings, and one meeting should not be prolonged to restlessness. When meetings are held at least once a week, it is easier to maintain the continuity of thought in discussions.

Meeting Time and Place

In some plants, it will be found best to hold the meetings at night, perhaps in a convenient meeting place downtown, or in a class-room in one of the local school buildings. In other stations, the meeting can be held immediately following the day shift in a suitable room at the plant. This latter meeting place has two leading advantages. Only the members of the morning and relief shifts make special trips to attend the meetings and some of the men on the evening shift have work of such a nature that they can be excused to attend classes without interfering with the normal operation of the plant.

In one plant, the meetings, at which the operating and maintenance problems are discussed, are not called "classes" but "operating and maintenance conferences," because that is what they really are, just as much so as a conference in any other business. The posted notices are headed "Operating and Maintenance Conference No. 1" and so on.

If the program is just being started in the plant, the topics can be outlined to cover the equipment in the order that the fuel is transformed into power, from "Fuel and Fuel-handling Equipment" to concluding discussions on "The Plant Meters and Instruments." The main topics can be taken up according to the following outline:

1. Fuel and fuel handling equipment.
2. Boilers, superheaters, preheaters and economizers.
3. Feedwater system and feedwater treatment.

4. Turbines and turbine lubricating systems.

5. Condensers.

6. Generators and generator cooling systems.

7. Exciters.

8. Plant high-voltage switches and transformers.

9. Plant auxiliaries, not included in discussions previously listed.

10. Plant meters and instruments.

This outline is brief and should be detailed in accordance with the kinds of equipment installed and the time allotted to cover the entire plant. If the plant has been in operation for some time, the subjects can be divided in two or three groups, with one group taken up each year until completed. In a new plant it will be the general desire of both the operators and management to cover the entire outline of the equipment the first year, even though the number of meetings is increased and some of the subjects are only briefly touched. It is important that the operators develop a general panorama of the operation of the station as soon as possible.

Subjects can then be taken up more in detail the second, third and fourth years, in the order of the greatest need for more discussion of the various classes of equipment.

Second Year Program

After the first year, it is time to start the secondary studies—mathematics, English, etc., preferably one at a time in the order of the greatest demand by the men. These subjects may be taken up in entirely separate classes with an instructor from the plant technical force or from one of the local faculties. It has been found highly successful to devote the last 15 min., or half hour, of the regular operating and maintenance conferences to one of these subjects. There are fine books for self-instruction, which are generally more readily understood than regular textbooks, and it is surprising, the vast amount of information that a group of interested men can master through consistent systematic study, even though only a quarter of an hour is set apart for instruction. If the group is large, it is sometimes advisable to divide it into smaller sections in order that instruction can be given to each group in accordance with the need of the individuals.

Each succeeding year, the subjects taken up regarding operation and maintenance, should be changed and treated from different angles, with different points brought out. Sessions can be devoted to discussions of changes in operating methods. If any new equipment has been added to the plant, it should receive its share of attention. The secondary subjects can be changed from mathematics, to heat or physics, and from physics to English, etc. It is frequently possible to obtain laboratory equipment from the local schools to perform experiments. Such topics as "Pumping Head," "The Correct Method of Pouring Bearings," "How to Temper Tools," "Machinist's Kinks," and a hundred and one others that are valuable and interesting, will command rapt attention.

Equipment Study

An operator is helped if he is given an opportunity to study the equipment he may operate in the job just ahead. Coördination of plant operation is enhanced when an electrical operator reports on a subject pertaining to steam equipment, or a turbine operator reports on an electrical subject.

One of the greatest sources of valuable information, suitable for discussion, is one that is frequently overlooked. The power plant magazines are a veritable mine of ideas coming into the station every month. When the educational program has progressed to the point where the more urgent topics on operation have been covered, it is time to devote at least two meetings of each term to the discussion of new equipment and new methods, prepared readily from magazine articles. The information found in the magazines is logically discussed by the operators at the heads of shifts, such as the "Watch" engineers. These men will have had the greatest experience and they should be better fitted to explain new equipment and new methods. Time devoted to such subjects as "Superposition," "Modern Improvements in Boiler Feedwater Regulators," etc., does much to broaden the viewpoint of an operator. An electrical operator may report on a subject of particular interest to him, as for example, "The Practical Application of the Electronic Tube in the Generating Station."

Conduct of Meeting

Educational meetings are never a place to show a man up, to magnify either his brilliance, or his incapacity. Since the whole educational plan is founded for the mutual benefit of all members, there is no time for "catch" questions, or questions that may trip up the speaker. Rather, the one giving the report is allowed to proceed uninterrupted until he has finished, when he can call for questions. No hard and fast rule can be set regarding this, however. He may have, inadvertently, made some erroneous statement which may confuse his entire discussion. In that case, if the error is not caught by the one in charge of the meeting, one of the other members may interrupt the speaker to inquire about the point involved. At other times, the nature of the subject under discussion by a member, may make it essential that the group leader, or instructor, coöperate with the reciting member throughout the talk. The instructor should be alert to prevent a slowing up, or lagging, during the progress of the meeting. Reports on turbine overhauls are necessarily detailed; and time can be allowed for general discussion after each individual item is covered by the speaker. Heated arguments during a conference rarely end in a definite conclusion: they are usually a waste of time.

It is difficult to hold the attention of a group during a talk without the use of some kind of an illustration. A convenient blackboard should always be available for sketches to simplify points difficult to describe or elucidate orally. It is sometimes convenient for the men to draw detailed sketches on the blackboard before the conference begins, perhaps on a day off duty. This greatly speeds up a talk and tends

to eliminate confusion. It is easier to hold the attention of the listener than to try to recapture his attention, once it is lost during an interruption needed to draw a detailed sketch.

Preparation for Talk

One of the most effective ways to prepare an illustration is to sketch the subject on a large sheet of paper, about three feet wide and from four to six feet in length, with colored chalk or crayons. By using several different colors, the various pieces of equipment and the many classifications of piping can be easily designated so they can be readily followed by the group. Ordinary wrapping paper serves quite well for this purpose, and it is inexpensive, too. It is surprising how one, or more, of these colored illustrations, made during spare time by the operator, help to hold attention and put a talk across.

Most subjects assigned in the power plant program require from two to four weeks for suitable preparation. It takes time and work properly to prepare a talk covering a period of from 30 min. to 1 hr. When a subject is assigned to an operator, he will first go to the particular equipment to be discussed and get a good mental picture of its arrangement in the plant, its piping or electrical connections, and its relation to the other equipment. He will discuss its construction and operation with the other members of his own shift, as well as, the members of the other crews. He will go to the plant engineers and obtain all the data possible regarding contract figures and maintenance problems which have been encountered with the machine. He will refer to magazines and bulletins for theory and other information. He will write two or three pages of penciled notes and draw his sketches; armed with this physical and mental equipment, he undertakes his talk with reduced diffidence. Preparation is the mother of confidence. Then, if he undertakes his talk in the easy conversational style he uses when talking with his fellow employes, singly, or in groups, that talk cannot help being a success.

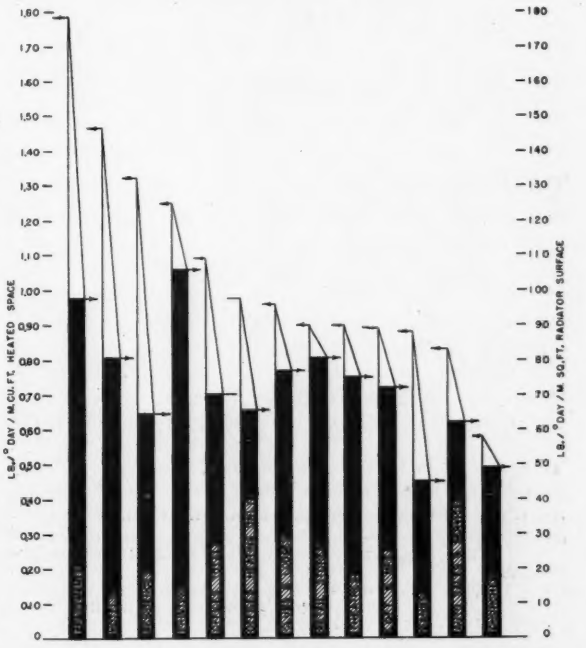
For several days after a certain classification of equipment is discussed in a conference, this equipment will be the subject of many group conversations in the plant. The equipment will be inspected and studied by the individual operators. This reaction to an operating and maintenance conference, alone, makes the plant educational program a valuable adjunct to station operation.

While some metallurgists are busily engaged in achieving the maximum purity of metals for certain industrial applications, other metallurgists are just as busy in developing combinations, or alloys, of metals to meet special requirements as to strength, hardness or resistance to fatigue or corrosion. Production of alloys has thus become a special science in which nickel, alone or in combination with such other alloying elements as chromium, molybdenum and copper, is frequently used to give to iron or steel the special mechanical properties demanded of many modern industrial materials.

Estimating Steam Heat Requirements

Estimating the probable steam consumption of a building or a group of buildings is one of the common duties of an engineer. There is no lack of data on this subject and one has a wide choice of methods.

Largely through the metered services of the district heating companies, steam consumption records for different classes of buildings have been compiled and are available in the proceedings of the N.D.H.A. and the Transactions and Guide of the A.S.H. & V.E. Some of this data has been used in this chart showing the steam consumption on two different bases. On



Steam consumptions of different types of buildings vary greatly

the right hand scale, and indicated by the solid bars, is the steam consumption in pounds per degree day per thousand square feet of equivalent steam radiator surface. Some people object to this method because radiator surface is sometimes excessive or deficient.

If you are one of those, you may prefer the left hand scale, referring to the outlined bars, giving the steam consumption per degree day per thousand cubic feet of heated space. Heated space in this case being approximately 80 per cent of the gross cubage as calculated by architects, because, outer walls, unheated basements and unheated attics are left out.

In both cases the figures include steam requirements for domestic hot water during the heating season. An average of 31 companies reporting for 1937 are summarized by the N.D.H.A. as 72.8 lb. of steam sold per degree day per 1000 sq. ft. of equivalent steam radiation, while 33 companies reported an average of 0.8574 lb. per thousand sq. ft. of space heated.

Turbine Reblading Pays

Six per cent decrease in water rate, amounting to more than $13,000 annually, results from partial reblading of 25,000-kw. turbine.

By J. B. COTTER

Supt. of Power Stations
Central Illinois Pub. Service Co.
Grand Tower, Ill.

EFFICIENCY LOSSES due to eroded blades are greater than commonly considered, a fact that is amply demonstrated by a recent reblade job on a 25,000 kw. unit. Water rate tests after replacements of the 26 cylinder row and the last four rows on the spindle, 26, 27, 28 and 29, showed some six per cent reduction over a test made previous to the change. The turbine, supplied with 390 lb. ga. 700 deg. F. steam, has operated 73,991 actual service hours since installation in 1924 and has produced 1,036,536,000 kw. hr. Based on the 1937 production, the 6 per cent change in water rate indicates a saving of over $13,000 for the year. This saving proves conclusively that reblading is justified even though not necessary from actual or incipient blade failure.

All five rows removed were the original blades of carbon steel. The new blading was of stainless steel, well polished and this polish in itself plays a part in reducing friction in the steam passages. The major portion of the 6 per cent reduction in water rate is, however, explained by the condition of the old blades as shown by the accompanying photographs. A casual glance is not sufficient, but, a close study of the old blades and a comparison with the new ones makes the reason for the improvement in performance apparent.

All the blades removed had been in service the full time of 73,991 hr. and the fact that no dirt or foreign deposits were found on them indicates a good quality of steam. Figure 1 shows one old blade and one new blade from each of the five rows. On the 26 cylinder row blade erosion is evident along the entire length of the blade but is very deep on both edges near the cylinder wall. At this location the inlet edge erosion resulted in a quite uniform and symmetrical cut whereas on the outlet edge the erosion effect was more ragged. The three semicircles in the inlet edge are tacking wire holes and are not due to erosion.

Erosion on the inlet edge of this row near the cylinder wall is more evident in Fig. 3 a photograph taken before the blades were removed. This was so

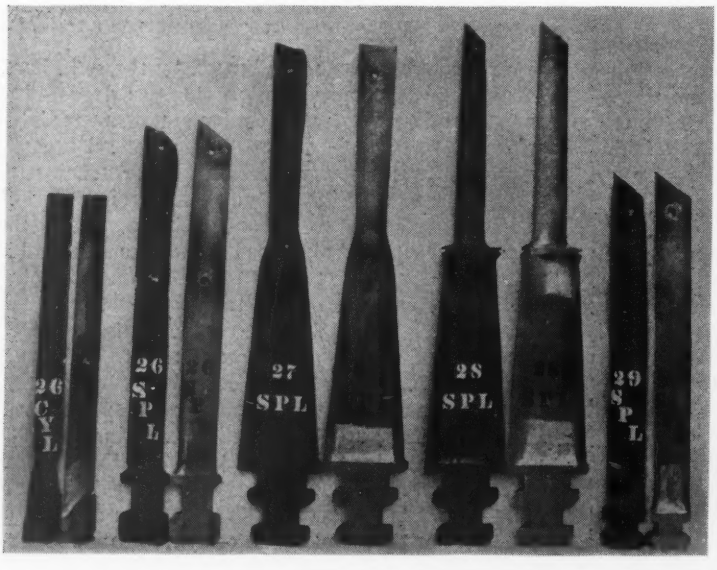


Fig. 1. (Below) Typical blades from each of the five rows replaced in the reblading job on a 25,000 kw. turbine. The old blades of carbon steel installed in 1924 had 73,991 actual service hours. The new blades are of stainless steel

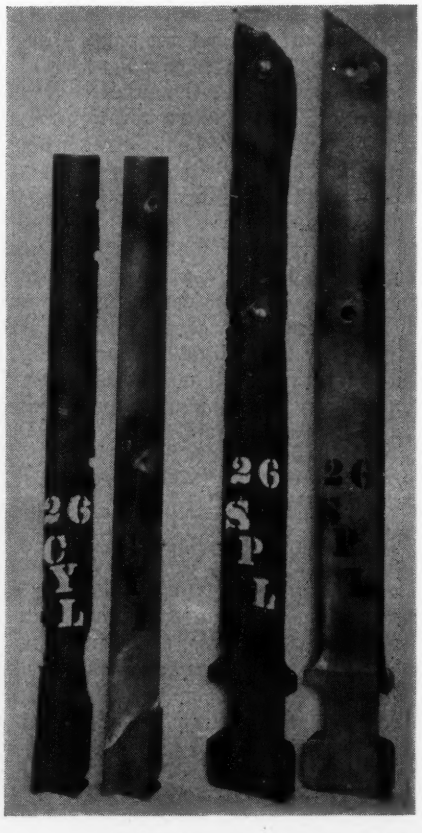


Fig. 2 (Right). Larger view of the 26 cylinder and spindle rows, shown at the right of Fig. 1. The inlet edges are at the right

bad that by looking downstream a clear opening could be seen and the resulting decrease in reactive effect of the steam flow at this point can well be imagined.

Erosion on the 26 spindle row was also excessive as shown by the curvature on the inlet edge, the ragged profile on the outlet edge and the tip which was eroded

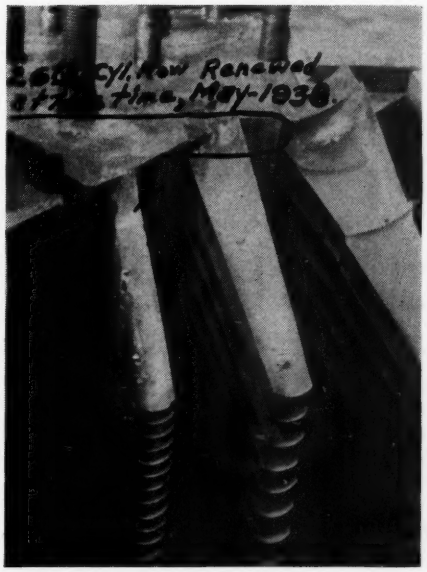


Fig. 3. Erosion of the 26 spindle row was so bad near the cylinder wall that a clear passage could be seen when looking downstream

almost completely away to give excessive tip clearance for steam spillage. Blades from both of these rows are shown at the right by Fig. 2 for comparison with the others and in larger size to give a better idea of the erosion effects. The change in shape is apparent by a comparison with the corresponding new blade.

Tip Speeds

The two spindle rows 27 and 28 show more uniform erosion throughtout the entire length and the alteration in shape is evident from a comparison with the new blades, the change in tip profile being particularly evident. Again on the 29 spindle row the tip erosion is very outstanding and considerable of the edge has disappeared although in general blades of this row showed less erosion than those in the other four.

Based on a load of 22,000 kw. and 80.5 deg. F. circulating water the water rates before and after rebladding were 11.73 and 11.01 lb. per kw-hr. respectively, an actual saving of 6.14 per cent. Corresponding vacuum conditions were 27.30 and 27.68 in. of Hg. and the tip speeds of the various spindle rows for comparative purposes in feet per second, are: 26 row, 779.5; 27 row, 834.5; 28 row, 862; 29 row, 738.3.

Some features which are already assured for the National Exposition of Power and Mechanical Engineering to be held in Grand Central Palace, N. Y., Dec. 5 to 10 are: Oil burners for No. 6 oil with viscosity regulation to control the amount of oil burned, regardless of viscosity; boiler water control without the use of floats and valves, for 150 hp. or smaller boilers; pipe covering of various materials and refractories for furnace and arch construction; separating valve to remove water and solids from a current of steam or compressed air; also filters for cleaning inlet air to combustion engines; pipe line appliances such as center-spring gasket, tube couplings, installation of metal hose and tubing; transmission systems, including rope, belt and chain, clutches, variable speed control units and pulleys; new designs of stokers; water conditioning equipment; a large variety of power plant specialties. All exhibits are planned to be informative and educational for the benefit of designers and operators of power plant equipment.

Evaporative Cooling and The Wet Bulb Reading

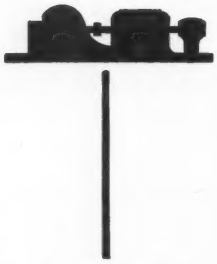
Evaporative Cooling of water depends upon the following factors: Large extent of water surface, either in drops or wetted surface; the wet-bulb temperature—a function of the dry-bulb temperature and the relative humidity—the absolute lowest limit to which water can be cooled evaporatively and which in practice is approached but never reached; the quantity of air coming in contact with the water surface, its time of contact, and its relation to the quantity of water cooled known as the air-water ratio; the velocity with which the air scours the water surface.

The wet bulb is beyond our control. Suffice to say that the wet-bulb temperature to be chosen as the basis of tower selection should not be so high as to occur but a few hours per year, nor so low as to result in inadequate cooling over much of the hot season. The mean of the daily high wet bulbs of the hottest month of the year usually results in a suitable figure. A closer study of the wet-bulb conditions may be made from local weather-bureau data, such study indicating the probable frequency of each wet bulb during a year or a season.

Design of the tower rests largely with the manufacturer and is, except as discussed above, beyond the scope of this paper. The choice of water quantities to be cooled and the cooling range to meet required heat dissipation, together with its position in the temperature scale is, however, subject to considerable choice on the part of the purchaser. Extensive experience in the cooling tower field indicates to the writer that the purchaser is often unaware that modification of these factors may reduce the size of cooling tower very considerably.

Cost Balance in Closed Systems

These modifications depend to some extent on the requirements of the equipment which the tower serves, especially so in the case of condensers and heat exchangers. In general a larger tower calls for a smaller heat exchanger and vice versa, so that the selection of both tower and heat exchanger should be studied as a combined unit to obtain greatest economy. Gustave J. Bischof before the A. S. M. E. at Dallas, Tex.



MODERN TURBINES*

Life changes pretty rapidly for us these days and we find it hard to adapt ourselves to continually changing conditions. Changing conditions in Industrial Power Plants make life equally one of changes for their turbines, but as Mr. Newman points out in this article, the turbine is readily adaptable to new conditions. Last month Mr. Newman told us how to estimate what to expect when we changed the rating—this month he takes us into his confidence and tells us how to figure quickly and easily what to expect from our steam turbines when we change the steam conditions.

By
L. E. NEWMAN
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Lynn, Massachusetts

IF STRENGTH of materials could be ignored, a 1000 kw. low-pressure condensing steam turbine could carry a load of over 50,000 kw. by operating it with the steam conditions of a superposed turbine. And cutting the throttle pressure of any steam turbine to half of its normal value will reduce the load carrying capacity more than half. But cutting the exhaust pressure to half its normal value will *increase* the load carrying capacity. These are illustrations, practical and fantastic, of what can be expected when steam conditions are changed.

Considering all of the variables affecting the steam rates and capacity of a steam turbine, determining what to expect when conditions change, may look like a hopeless task. But this is not the case. A few fundamentals govern the actions of a steam turbine, and knowing these it is easy to estimate performance at new steam conditions when the performance at the design conditions can be used as a "bench-mark." Last month, methods were described for estimating price, shipment, steam rates, and dimensions when changing the *rating* of a turbine generator set, but maintaining all other conditions constant. Now we shall hold the rating constant, and vary the steam conditions.

Should an emergency condition arise, for example, when it became necessary to operate a 2000 kw. condensing turbine designed for a normal throttle steam pressure of 400 lb. at a throttle pressure of 200 lb., a simple calculation would indicate that its maximum capacity would be limited to about 1000 kw. And a few more minutes time would suffice to estimate that its steam rate would be increased about 20 per cent. Or, to cite another illustration, a change in process steam requirements might make it desirable to increase the exhaust pressure of a noncondensing turbine from say 10 lb. to 15 lb. Here again the problem of estimating the approximate loss in capacity and economy can be easily figured. All that is necessary to solve these and similar problems is knowledge of a few easily understood fundamentals.

There are two distinct phases to a study of this type. The first has to do with turbines now installed that were designed for one condition but will be operated with other conditions. The second has to do with contemplated new turbines which may be required to operate under more than one set of conditions. Both problems are closely related. Fundamental principles used to determine what loss in capacity to expect when dropping the steam pressure of an existing turbine may be used to determine whether it is practicable to design a new turbine with sufficient capacity to carry rated load at reduced steam pressure. When the possibility of changed operating conditions is foreseen *before* a turbine has been built, it is obviously easier to fit it to the new conditions than otherwise. But even though an existing turbine was built with no knowledge of conditions it might later be required to meet, it still has lost none of its inherent flexibility. With modifications to its steam path it may still be adapted for conditions other than those for which it was originally designed.

By this adaptability to meet changing conditions is not meant that there are no limits to a turbine. An old low pressure condensing turbine could not be rebuilt into a superposed turbine. Nor would the casing itself always be strong enough to withstand

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what may seem to be only minor increases in pressure or temperature. Only the manufacturer of the turbine can answer questions relating to the limiting conditions for a specific turbine. But with the methods described in this article many questions on capacity and performance at new conditions may be answered without consulting the manufacturer except perhaps to check your own estimates.

The basic fundamentals governing change in capacity and economy with change in steam conditions are these, which while not strictly correct may be used for approximations. (See Table No. 1).

(A) CHANGE IN MAIN PRESSURE causes
1. Increase or decrease in the steam flow capacity proportional to the ratio of the proposed new pressure to the design pressure, both expressed as absolute pressures.
2. Increase or decrease in steam rates proportional to the ratio of the theoretical steam rate at the new throttle pressure to the theoretical steam rate at the design pressure.
3. Increase or decrease in load carrying capacity proportional to the change in steam flow divided by the change in steam rate. [(1) above, divided by (2)].

(B) CHANGE IN INITIAL SUPERHEAT, OR TOTAL TEMPERATURE, causes
1. A small change in steam flow capacity.
2. Increase or decrease in steam rates proportional to the ratio of the theoretical steam rate at the new throttle temperature to the theoretical steam rate at the design temperature.
3. Negligible change in load carrying capacity.

(C) CHANGE IN EXHAUST PRESSURE causes
1 No change in steam flow capacity.[1]
2. Increase or decrease in steam rates proportional to the ratio of the theoretical steam rate at the new exhaust pressure to the theoretical steam rate at the design exhaust pressure.
3. Increase or decrease in load carrying capacity proportional to the ratio of the theoretical steam rate at the design exhaust pressure to the theoretical steam rate at the new exhaust pressure.[2]

[1]This holds true for most cases, but does not apply to all noncondensing turbines. If the ratio of main pressure to exhaust pressure is small, an increase in exhaust pressure will decrease the steam flow capacity. This case is encountered most frequently with high back pressure noncondensing turbines.
[2]True in most cases, but will be modified when Footnote (1) applies.

Each of these rules has been placed in a convenient tabulation, Table 1, and each will be illustrated by an example, but first a word of warning. *Without consulting the manufacturer of an existing turbine it is not safe to make estimates based on*:

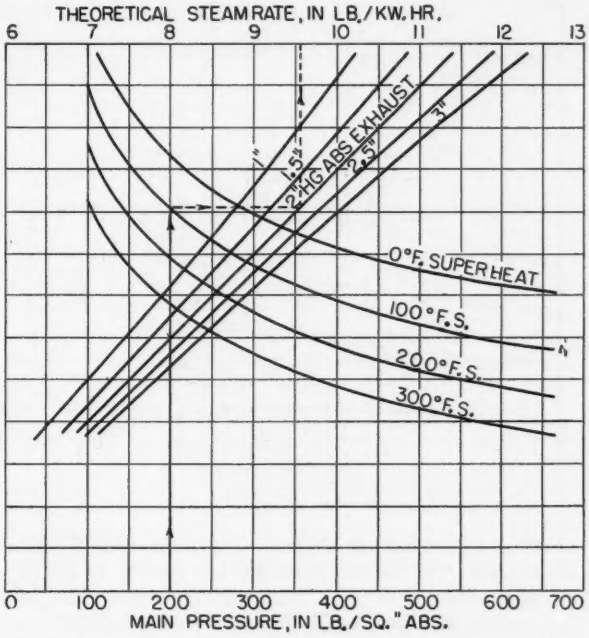


Fig. 2. Approximate Theoretical Steam Rates for Condensing Turbines
NOTE: Absolute pressure in lb. per sq. in. = lb. per sq. in. gage + 15 lb. (at sea level)
Absolute pressure, in inches Hg. = 30 minus the Vacuum, in inches Hg. (at sea level)

a. An increase in initial pressure or temperature.
b. An increase in exhaust pressure of any noncondensing turbine, or a substantial decrease in exhaust pressure of high back pressure, noncondensing turbine.
c. Any increase in capacity over the rated maximum capacity.

It is safe to make estimates based on:
a. A decrease in the initial pressure or temperature.
b. An increase or decrease in exhaust pressure of condensing turbines, provided the new exhaust pressure is less than atmospheric.
c. A 20 per cent or less decrease in the exhaust pressure of noncondensing turbines.

These limitations do not apply to proposed new turbines, provided that the range of conditions to be covered is not beyond practicable limits and the manufacturer bases his proposal on a design to meet all of the anticipated conditions of operation.

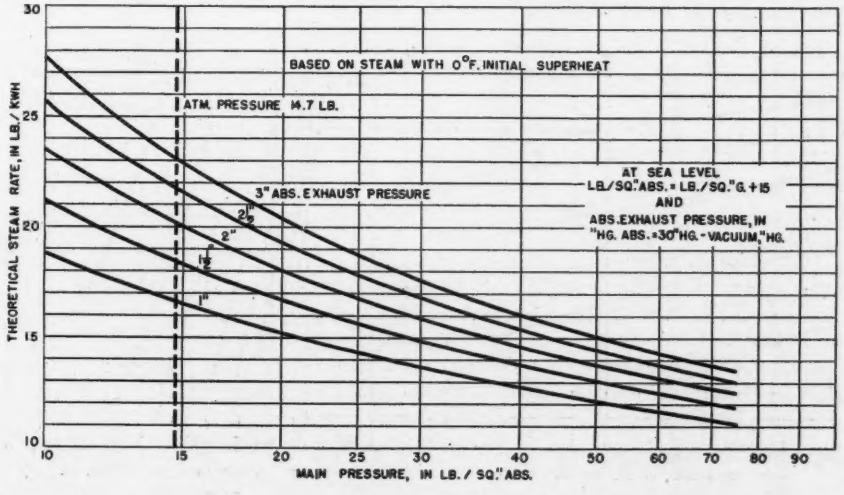


Fig. 1. Approximate theoretical steam rates of a low pressure condensing turbine based on steam with 0 deg. F. initial superheat

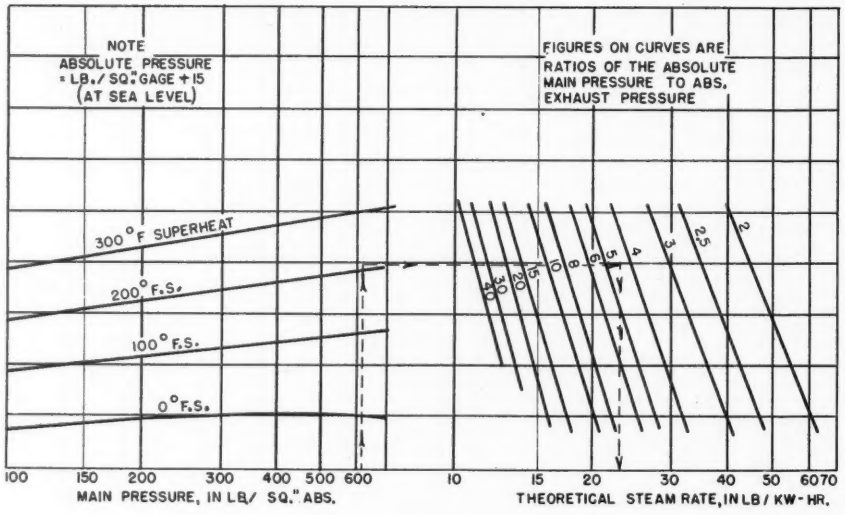


Fig. 3. Approximate theoretical steam rates, Noncondensing. NOTE: Figures on Curves are ratios of the absolute main pressure to absolute exhaust pressure

It may seem that a fence has been put around almost all of the workable area, but in the following examples it will be shown that a large field remains for estimating performance at conditions other than design conditions.

For the first example, let us take the not infrequent case where a new 400-lb. boiler and turbine are to be installed in a station now having all 200 lb. boilers. When the new 400-lb. boiler is down for cleaning, inspection, or repair, the new 400-lb. turbine will be required to operate with 200 lb. steam from the existing boilers. And the problem may be to determine the maximum capacity of the turbine at 200 lb., and perhaps the steam rate when operating with reduced pressure.

Given conditions: [3]

Rating.....2000 kw. at .80 power-factor
Normal main pressure.....400 lb. abs.
Normal superheat.....200 deg. F.
Normal exhaust pressure.....2" Hg. abs.
Maximum capacity.....2500 kw. at 1.0 power-factor
Steam rate at max. capacity.....11.8 lb./kw.-hr.
Max. steam flow (11.8x2500).....29,500 lb./hr.

[3]Prevous articles in this series have given methods for quickly estimating the performance of new turbine-generator sets.

Problem:

To determine maximum capacity and corresponding steam rate at new initial steam conditions of

Emergency main pressure.....200 lb. abs.
Emergency superheat .....100 deg. F.

Solution:

Using Table 1 (formula A-1),
Steam flow capacity at 200 lb.

$$= \frac{MP_2}{MP_1} \times \text{steam flow capacity at design conditions}$$

$$= \frac{200}{400} \times 29{,}500 = 14{,}750 \text{ lb./hr.}$$

Using Figure 1, and Table 1 (formula A-2),
Theoretical steam rate at

400 lb. abs., 200 deg. F., 2" abs. = $TSR_1 = 7.9$
200 lb. abs., 100 deg. F., 2" abs. = $TSR_2 = 9.55$
Steam rate at 200 lb.

$$= \frac{TSR_2}{TSR_1} \times \text{steam rate at design conditions}$$

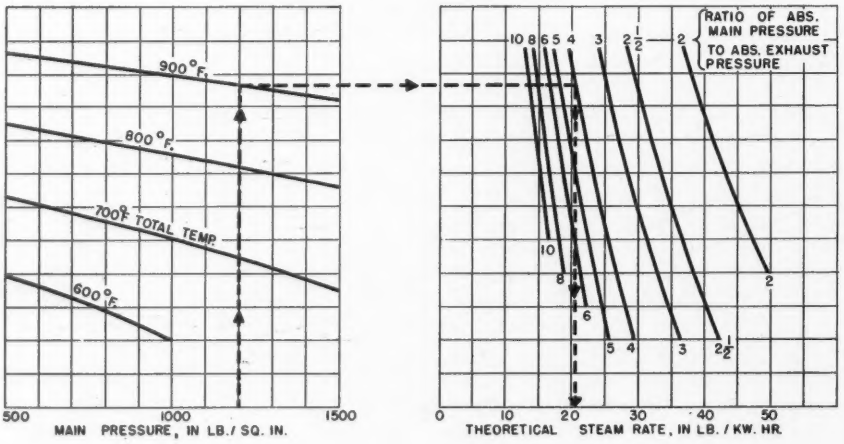

900° F.
800° F.
700° TOTAL TEMP.
600° F.
500 1000 1500
MAIN PRESSURE, IN LB./ SQ. IN.
RATIO OF ABS. MAIN PRESSURE TO ABS. EXHAUST PRESSURE
10 8 6 5 4 3 2½ 2
0 10 20 30 40 50
THEORETICAL STEAM RATE, IN LB./ KW. HR.

Fig. 4. Approximate theoretical steam rates for superposed turbines NOTE: At sea level lb. per sq. in. A. = lb. per sq. in. G + 15

$$= \frac{9.55}{7.9} \times 11.8 = 14.26 \text{ lb./kw.-hr.}$$

Using Table 1 (Formula A-3)
Max. capacity at 200 lb.

$$= \frac{MP_2}{MP_1} \times \frac{TSR_1}{TSR_2} \times \text{capacity at design conditions}$$

$$= \frac{200}{400} \times \frac{7.9}{9.55} \times 2500 = 1035 \text{ kw.}$$

The turbine, then, if normally designed for 400 lb. main pressure will be able to carry a maximum load on the generator of 2500 kw. at 1.0 power factor when operated at its design conditions. But at 200 lb. main pressure this same turbine with no changes of any kind will be able to carry about 1035 kw. If greater capacity than this is needed at 200 lb. the manufacturer of the turbine should be consulted.

Another type of problem frequently occurring and easily solved is that of determining the performance of a noncondensing turbine when operated with variable exhaust pressure. Many noncondensing turbines supplying steam for building heating operate with an exhaust pressure increasing or decreasing with steam demand. In severe weather steam demand is high resulting in increased pressure drops through heating mains. These pressure drops may be overcome by operating the turbine at a higher exhaust pressure. Usually the rise in exhaust pressure is not sufficient to encroach seriously on the load carrying capacity of the turbine, but the loss in economy (increase in steam rate) with increase in exhaust pressure is often worth considering. Such a problem is easily solved by using Table 1, formula C-2.

It will be noted from Table 1 that no correction has been included for change in efficiency with change in steam conditions. For small changes in any of the steam conditions the efficiency correction is slight; for very large changes the efficiency correction may be appreciable, but the answer will still be in the proper magnitude. And magnitudes alone are usually important when estimating what to expect when considering a sizeable departure from design conditions.

A second thing to observe in Table 1 is that it is just as easy to correct for changes in *every* condition as it is to correct for a change in only one of the conditions. The reasons for this are:

Steam flow capacity is dependent on the main pressure alone. (With occasional exceptions, previously noted.)

Steam rate is dependent on the theoretical steam rate, and it is just as easy to read the TSR for one set

(Continued on p. 648)

TABLE 1
TABLE OF FORMULAS FOR ESTIMATING PERFORMANCE AND CAPACITY WHEN STEAM CONDITIONS CHANGE

	A Main Pres.	B Superheat	C Exhaust Pres.
1. Steam flow capacity	$\frac{MP_2}{MP_1}$	1.0 approx.	1.0
2. Steam rate	$\frac{TSR_2}{TSR_1}$	$\frac{TSR_2}{TSR_1}$	$\frac{TSR_2}{TSR_1}$
3. Maximum output	$\frac{MP_2}{MP_1} \times \frac{TSR_1}{TSR_2}$	1.0	$\frac{TSR_1}{TSR_2}$

Where,

MP_1 = design main pressure, in lb/sq. in. abs.
MP_2 = proposed main pressure, in lb/sq. in. abs.
TSR_1 = theoretical steam rate at design steam conditions.
TSR_2 = theoretical steam rate at proposed steam conditions.

USE OF TABLE:

In each case the table gives the ratio by which the known quantity at the design steam conditions should be multiplied. Thus,

Steam rate at proposed new steam conditions

$$= \frac{TSR_2}{TSR_1} \times \text{steam rate at design steam conditions.}$$

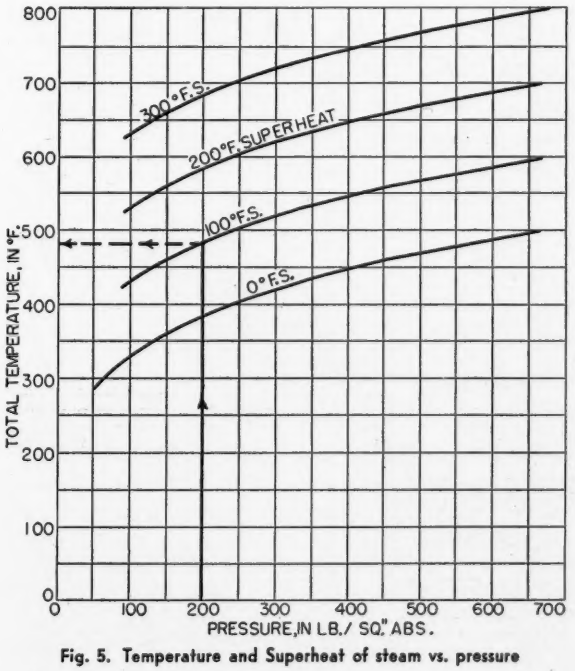


Fig. 5. Temperature and Superheat of steam vs. pressure

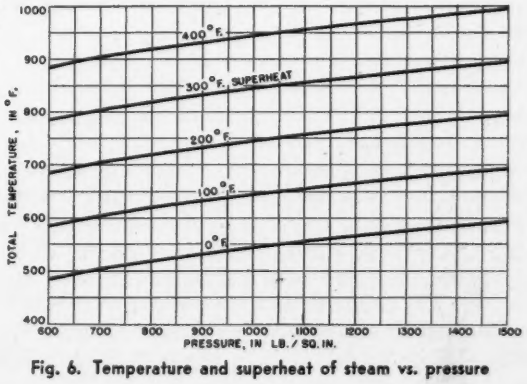


Fig. 6. Temperature and superheat of steam vs. pressure

MODERN

By H. S. WHITON

Chief Mechanical Engineer
Public Utility Eng. & Serv. Corp.
Chicago, Ill.

Extending practically from the Canadian border on the north to the Mexican border on the south and from the Pacific Ocean east to Pennsylvania, the Standard Gas & Electric Co. system serves power to extensive areas in nineteen states. Engineering work is carried on by the Public Utility Engineering & Service Corp. of Chicago, a mutual service company owned by the operating units.

OPERATING COMPANIES in the Standard Gas & Electric Co. system made no important additions to steam plants from 1932 to 1937. In 1936, however, it became evident that certain systems would need capacity in 1937 or 1938. Studies were therefore undertaken, by Public Utility Engineering & Service Corp. and the operating companies concerned, which eventually resulted in the installations described below. None are unique, and none differ materially from previous practice of this company except in the use of deaeration in the feed system.

Previous practice omitted deaerators, but endeavored to exclude air from the circuit to the extent that the main condenser could remove the residue. This proved to be a satisfactory scheme during continuous runs of equipment, but defective during starting periods, as an hour or more is needed after each start to purge the system of air. As adding efficient units to these plants may increase materially the number of starts per year, and aggravate the condition, deaeration has been installed in connection with all important new capacity.

Duquesne Light Company—Reed Station

In 1930, the first unit of Reed Station on Brunot Island, Pittsburgh, Pa., was put in service, the building being large enough for two units. In subsequent years, studies were made to determine the economics of various methods of adding generating capacity, such as topping existing units, extension of existing plants and building new plants, and various steam pressure and temperature cycles were investigated.

When it became evident that added capacity would be needed in the fall of 1938, it was decided to install the second unit at Reed Station, where building costs would be a minimum, coal handling facilities needed but little addition and minimum time would be required for completion.

A 60,000 kw., 1800 r.p.m., Westinghouse turbogenerator and a 55,000 sq. ft. Westinghouse condenser using 95,600 g.p.m. of circulating water were chosen. Steam conditions of 400 lb., 750 deg. F., 1½ in. back pressure, are slightly higher than for Unit No. 1 which was designed for 375 lb., 735 deg. F., 1 in. back pressure. Nevertheless, the existing boilers of Unit No. 1 can act as spares for Unit No. 2 with but slight loss in economy.

Experiences at Reed during the flood of 1936 prompted the engineers to depart from the Unit No. 1 design in several particulars. Unit No. 2 is hydrogen cooled, as this design permits keeping the generator dry with higher flood water than practical with the usual air cooled design. Vertical circulating water pumps were bought with longer shafts than those on Unit No. 1, to the end that, with one of these pumps connected to each condenser, both units are protected

Table I. Data on the principal steam generating stations of the Standard Gas & Elec. System

COMPANY & STATION	GEN. UNITS			BOIL.	STEAM		FUEL	F. BURN. EQUIP.
	TOTAL KW.	NO.	LARGEST KW.	NO.	PRES. LB./□"	TEMP. °F		
DUQUESNE LT. CO.								
BRUNOT ISLAND	116500	7	40000	55	200	500	SCREENINGS	STOKERS & P.C.
COLFAX	262500	6	60000	22	285		SCREENINGS	STOKERS & P.C.
JAMES H. REED	60000	1	60000	3	450	750	SCREENINGS	STOKERS
LOUISVILLE G.&E.CO.								
CANAL	18500	4	6000	12	185	550	SCREENINGS	STOKERS
WATERSIDE	92500	9	25000	24	240	600	SCREENINGS	STOKERS
NORTHERN STATES P.CO. (INTERCONNECTED SYSTEM)								
HIGH BRIDGE	67000	2	35000	8	315	700	SCREENINGS	STOKERS
ISLAND	20000	1	20000	3	325	700	SCREENINGS	P. C.
LA CROSSE	6500	2	4000	4	200	500	SCREENINGS	STOKERS
MINNESOTA VALLEY	20000	2	10000	3	350	725	SCREENINGS	STOKERS
RIVERSIDE	107000	4	35000	13	235 450	600 750		STOKERS
SIOUX FALLS	15500	3	7500	5	200	600	GAS	GAS & OIL
FARGO	10000	4	3000	5	250	550	SCREENINGS	STOKERS
GALENA	13250	5	4500	8	200	550	SCREENINGS	STOKERS
GRAND FORKS	5750	3	3000	5	225	550	SCREENINGS	STOKERS
MINOT	5800	3	2500	6	225	550	SCREENINGS	STOKERS
OKLAHOMA G.&E. CO.								
BEERBOWER	15000	1	15000	2	435	700	PETR. COKE	P. C.
BELLE ISLE	11000	4	4000	7	160	500	GAS	GAS & OIL
BYNG	16696	4	6000	11	180	500	GAS	GAS & OIL
HORSESHOE LAKE	65000	3	30000	9	300	700	COAL & COKE	STOKERS & P.C.
MUEY	30000	1	30000	3	450	750	GAS	GAS & OIL
RIVERBANK	22500	2	15000	6	240	600	GAS	GAS & OIL
SAN DIEGO CON. G.&E.CO.								
STATION B	64000	4	28000	7	250	700	GAS & OIL	GAS & OIL
SO. COLO. PWR. CO.								
CANNON CITY	7500	1	7500	4	225	550	SCREENINGS	STOKERS
PUEBLO	7500	1	7500	3	250	600	SCREENINGS	STOKERS
WIS. PUB. SERV. CORP.								
BAYSIDE	20000	2	10000	2	350	700	SCREENINGS	P. C.
MANITOWOC	10000	2	5000	4	250	500	SCREENINGS	STOKERS
OSHKOSH	9750	4	5000	4	250	550	SCREENINGS	STOKERS

UTILITY STATIONS

V—The Standard Gas & Electric System

to a higher flood level. Motor driven condensate pumps have vertical extended shafts, thus permitting operation at higher flood level than would be possible with horizontal pumps similar to those of Unit No. 1.

Two B & W Stirling type boilers were installed, with economizers, air heaters and superheaters, as shown by Fig. 1. Maximum temperature is limited by means of a B & W desuperheater. Westinghouse underfeed stokers with link grate sections longer than used with Unit No. 1 serve these boilers, which have a rear water wall bent inwardly to form a mixing throat in the furnace. The boilers are capable of producing 300,000 lb. of steam per hr. continuously, or 350,000 lb. per hr. maximum. Ash sluicing equipment differs from that installed with Unit No. 1 in that the discharge is through a closed conduit so located that ashes can be removed when the island is flooded.

Unit No. 2 is expected to be in commercial service late this year.

Table II. Detailed equipment data on steam stations constructed or under construction as part of the current building program of the Standard Gas & Electric System

OPERATING CO.	STATION	LOCATION	THROTTLE		BOILERS									
			PRES.	TEMP.	NO.	CAPACITY	BOILER	SUPERHEATER		ECON.	AIR HEATER		FLY-ASH COLLECTOR	W.W.
			LB./SQ.IN.	°F.		LB./HR. EACH	SQ. FT.	SQ. FT.	T. CONTROL	SQ. FT.	SQ. FT.	TYPE		SQ. FT.
DUQUESNE LIGHT CO.	JAMES H. REED	PITTSBURGH, PA.	400	750	2	350,000	30,564	9820	DESUP.	8500	27,800	TUBE.	CINDER V. FANS	3308
LOUISVILLE GAS & ELECTRIC CO.	CANAL	LOUISVILLE, KY.	450	750	1	350,000	9440	6200	BY-PASS	13,540	37,700	TUBE.	COTTRELL	4305
NORTHERN STATES PWR. CO.	GRAND FORKS	GRAND FORKS, N.D.	200	515	1	75,000	9110	470	———	———	———	———	———	———
NORTHERN STATES PWR. CO.	FARGO	FARGO, N.D.	400	750	1	90,000	14,142	1800	———	———	———	———	———	———
NORTHERN STATES PWR. CO.	RIVERSIDE	MINNEAPOLIS, MINN.	375	750	2	275,000	12,730	3820	———	17,280	———	———	CINDER V. FANS	1800
SAN DIEGO CON. G. & E. CO.	STATION B	SAN DIEGO, CALIF.	235	725	2	200,000	17,299	2615	———	———	16,270	TUBE.	———	

STATION	FURNACES				AUXILIARIES								GENERATING UNITS				
	VOL.	H.REL'S	TYPE	TYPE	F. D. FANS				I.D. FANS				NO.	RATING	SPEED	B. PRES.	COND'SR	GEN. COOL.
	CU. FT.	B.T.U./CU.'	BOT.	FIRING	NO.	C.F.M. EACH	IN. H_2O	°F.	NO.	C.F.M. EACH	IN. H_2O	°F		KW.	R.P.M.	LB./SQ.IN. ABS.	SQ. FT.	
JAMES H. REED	15,982	30,000	CLK. GR.	STOKER UF.	2	68,500	13.00	100	2	108,000	14.50	375	1	60,000	1800	1.50	55,000	HYD.
CANAL	21,385	21,800	DRY	P.C.	1	125,000	12.00	100	1	200,000	12.00	385	1	25,000	1800	1.50	22,250	AIR
GRAND FORKS	3170	34,000	MULT.AP.	STOKER SP.	1	30,000	1.75	70	0	———	———	———	1	3000	3600	2.00	3780	AIR
FARGO	5900	22,800	MULT.AP.	STOKER SP.	1	38,000	2.00	70	1	82,000	2.40	395	1	5000	3600	2.00	3850	AIR
RIVERSIDE	12,000	31,000	CLK. GR.	STOKER UF.	2	125,000	7.20		4	105,500	9.00	305	1	35,000	1800	1.00	24,400	AIR
STATION B	8156	32,100	DRY	GAS & OIL	1	63,500	9.60	100	1	115,500	6.80	375	1	35,000	1800	1.50	34,350	AIR

Northern States Power Co. of Minnesota
Riverside Station

Load on the interconnected system of Northern States Power Co. had developed in 1936 to a value which indicated the need for additional steam generating capacity by the summer of 1938. Riverside Station in Minneapolis is closest to the load center and had boiler room space and other facilities available. Therefore, the No. 2 Unit was duplicated by purchase of a 35,000 kw., 1800 r.p.m., General Electric turbo-generator, bled at the seventh, ninth and twelfth stages for feedwater heating. The evaporator is connected to the seventh, and vapor is condensed in the ninth stage heater.

This new unit, No. 1, uses the same steam pressure and temperature as No. 2 Unit installed in 1930, 450 lb., 750 deg. F. These steam conditions were chosen because the system has large hydro-electric development which imposes a rather poor capacity factor on the steam stations, so the expense incident to building for lower heat rate could not be justified.

Two Foster Wheeler boilers, each capable of producing a maximum of 275,000 lb. of steam per hr., were installed as No. 2 Unit, is equipped with three 250,000 lb. maximum capacity boilers, which, it was felt, gave adequate spare boiler capacity. Circulation difficulties in the boilers installed with Unit No. 2 prompted the use of "high head" boilers for Unit No. 1. Although space available was scarcely adequate, a design Fig. 2 was worked out, which results in a satisfactory hydraulic head on the top tubes.

The Ross condenser is hung on the turbine exhaust flange with jacks provided to take the excess load when the steam space is filled with water to test for leaky tubes. These jacks are supported on beams, the deflection of which is used as indication of the load taken by the jacks, so that the turbine exhaust flange will not be overstressed during test.

Condenser surface is 24,400 sq. ft., and two circulating water pumps are provided. One motor driven

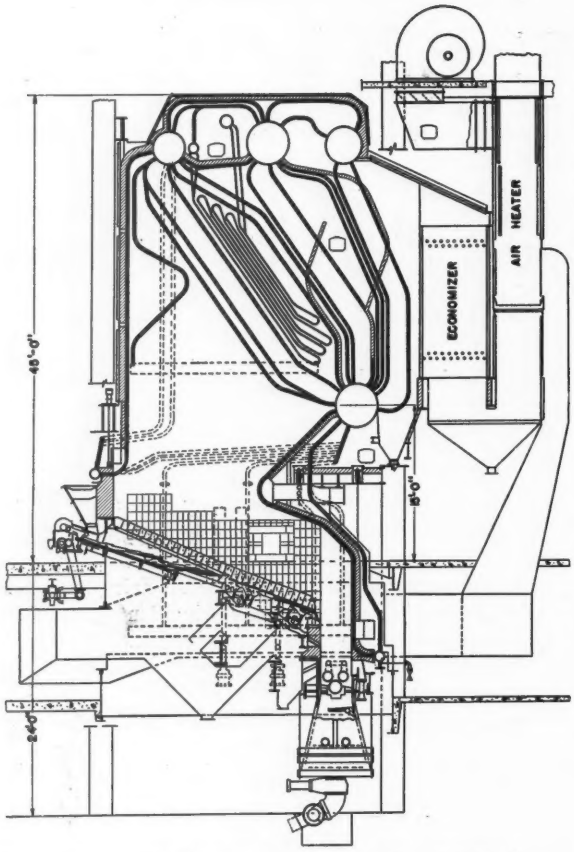


Fig. 1. Two new 300,000 lb. per hr. boilers and a 60,000 hydrogen cooled generator will be in service at the James A. Reed Station of the Duquesne Light Co. this fall

pump of 20,000 g.p.m. capacity is for use with extremely cold circulating water, and one 30,000 g.p.m. dual drive pump will suffice with moderately cold water. Both circulating water pumps will be used during the summer, when the circulating water may reach 85 deg. F.

A deaerator was installed to handle make-up to evaporators for both units, in an effort to avoid CO_2 corrosion in the evaporator condensers. A cross-connection is provided in the condensate circuit so that when starting either unit its condensate can be sprayed into the condenser of the other unit (if running) to deaerate it until the oxygen content is low enough to permit use in the normal boiler feed circuit. No. 1 turbo-generator unit was put in service early in August, and the boilers will be available this fall.

Grand Forks Station

In 1937 a 3000 kw. Allis-Chalmers turbo-generator, a 3780 sq. ft. Allis-Chalmers condenser using 4000 g.p.m. of circulating water and a 75,000 lb. per hr. Foster Wheeler bent tube boiler (Fig. 5) were put into service in this station. Steam conditions are 200 lb. ga., 525 deg. F., 1½ in. back pressure, and the turbine is bled at from 2 to 8 lb. ga. for feed heating and at from 3 to 10 lb. for district heating system. Because of space limitations, the condenser is installed at an angle of 30 degrees to the turbine center-line. Circulating water supply is common to all units. The condenser is arranged with air offtakes at the top. Steam enters at the top and passes through a shallow bank of tubes to the bottom of the shell, then around two baffles, and rises through the tube bank to the air cooler sections with air offtakes at either end of the shell. To date, no test figures are available, but operating logs indicate good performance.

Lignite is burned on flat dumping grates served by spreader stokers, with forced and induced draft. This equipment also burns satisfactorily certain eastern coals which are available at times. The ash pit is divided longitudinally so that air supply may be cut off from individual sections of the grate when cleaning fires, thus permitting the cleaning of any section without material reduction in output.

Fargo Station

The Fargo Plant is located on a restricted site between the Northern Pacific main line and an adjacent switch track which serves stores and warehouses

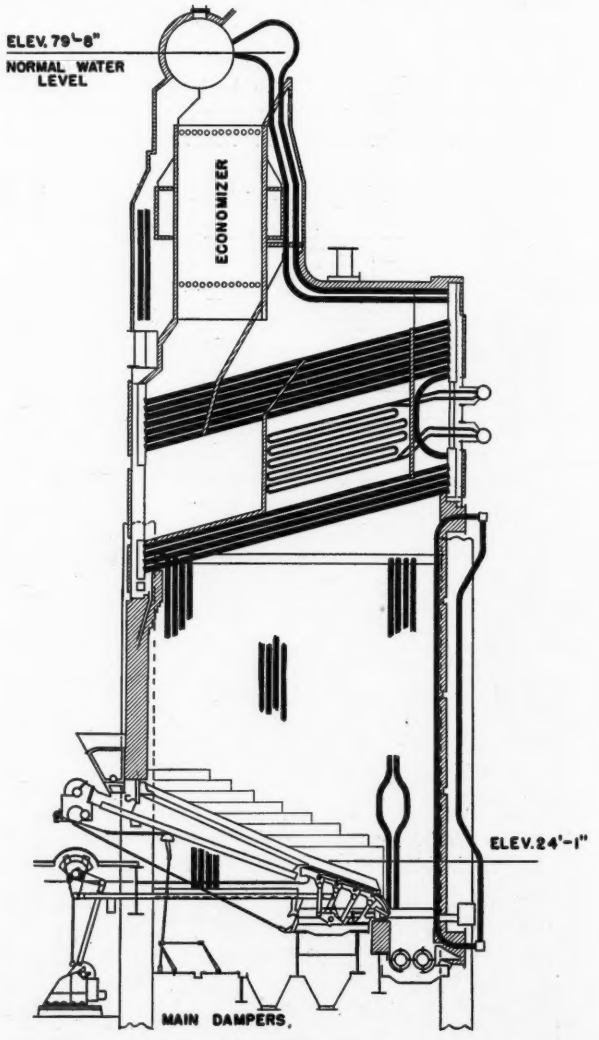


Fig. 2. Cross section of the new 275,000 lb. per hr., 450 lb. high head boilers for the Riverside Station of the Northern States Power Co. at Minneapolis

on the north half of the block. Four units, totalling 10,000 kw., are installed in the old building, each arranged to bleed to a district heating system. All condensers are connected to a common circulating water system with pumps at the river about 2300 ft. away. Five boilers supplied steam at 225 lb., 525 deg. F.

Two of these boilers have been removed this year, and one Vogt straight tube boiler installed in their place. This boiler is designed for continuous output of 65,000 lb. of steam per hr. at 400 lb., 700 deg. F., when burning lignite, but is operated at present at 225 lb., 525 deg. F. Maximum output with lignite is 80,000 lb. of steam per hr., or with West Virginia splint 100,000 lb. of steam per hr.

Both boilers will be fired with lignite on flat dumping grates by means of spreader stokers. Ash pits will be divided as described for Grand Forks Station.

Forced and induced draft will be provided, the induced draft fan having cinder catching vanes to reduce the amount of fly ash emitted by the stack. In addition, the bottom of the third pass is to be fitted with a soot sucker to remove the fly ash which accumulates there. All boilers and cinder catching fans will be connected to a new vacuum ash removal system which will deposit ashes in an elevated tank in the yard for disposal by truck.

A track hopper and belt conveyor system will be installed to serve overhead bunkers for supply to all boilers. As the south end of the boiler house is not

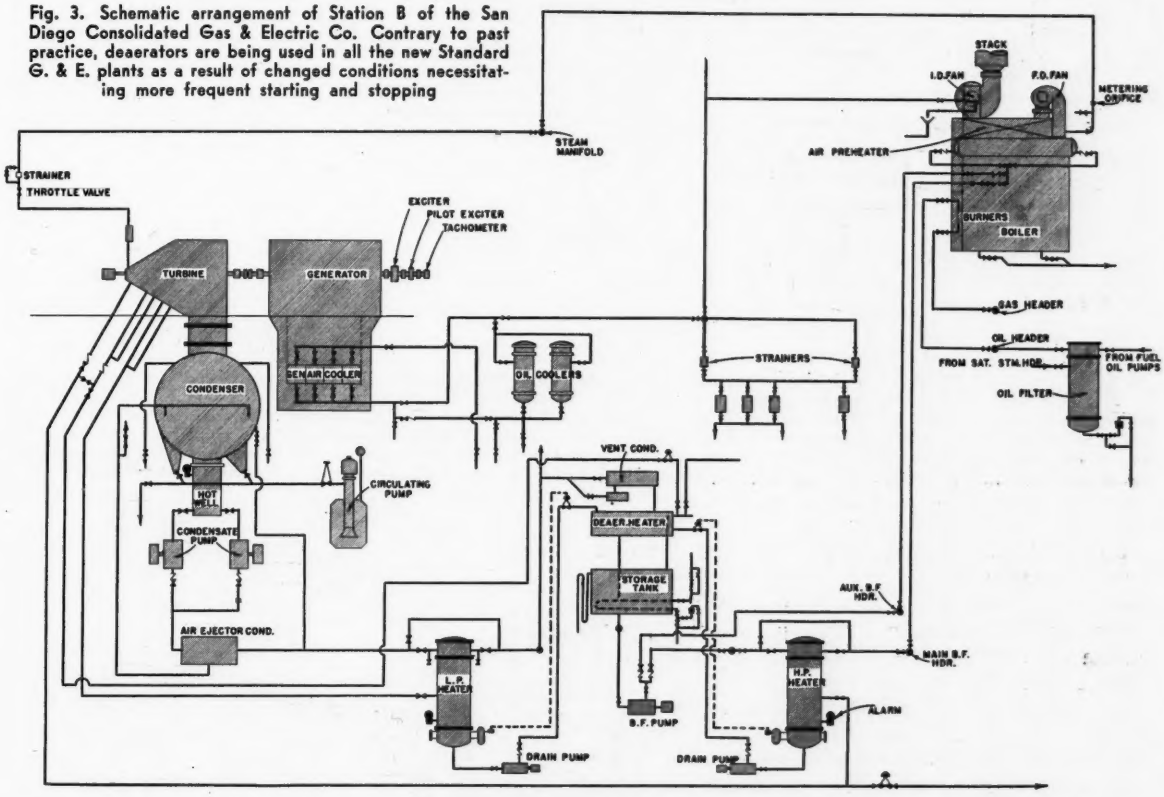


Fig. 3. Schematic arrangement of Station B of the San Diego Consolidated Gas & Electric Co. Contrary to past practice, deaerators are being used in all the new Standard G. & E. plants as a result of changed conditions necessitating more frequent starting and stopping

To handle economically electrical loads in excess of those required to furnish steam to the district heating system, work is now in progress to enlarge the building to house two 5000 kw. turbo-generators and two boilers, each capable of producing 80,000 lb. of steam per hr. at 400 lb., 750 deg. F., when burning lignite. The general arrangement is shown by Fig. 7.

One Westinghouse turbo-generator unit (3600 r.p.m.) and one Vogt boiler are now on order and are to be ready for service at the end of the year. The turbine will be bled at two points for feedwater heating, but will not serve the district heating system. It will exhaust to a 3850 sq. ft. Ross condenser using 4100 g.p.m. of circulating water. One 3500 g.p.m. circulating water pump will be removed and a 6000 g.p.m. pump substituted, thus providing two pumps of equal size.

suitable for overhead bunkers, however, the two south boilers will be temporarily coaled by lorries filled as needed through spouts from the new overhead bunkers.

Louisville Gas & Electric Company—Canal Station

The Louisville Gas & Electric System, together with certain of its interconnections, are normally served from the Ohio Falls Hydro Plant. Hydro capacity usually falls off during the winter months, necessitating steam stand-by for peak load periods. The lack of steam capacity at interconnected plants, coupled with the increasing peak requirements, required the addition of steam generating capacity at Louisville, available for operation by the fall of 1937.

Low use factor coupled with high availability necessitated as prime considerations of design, low first

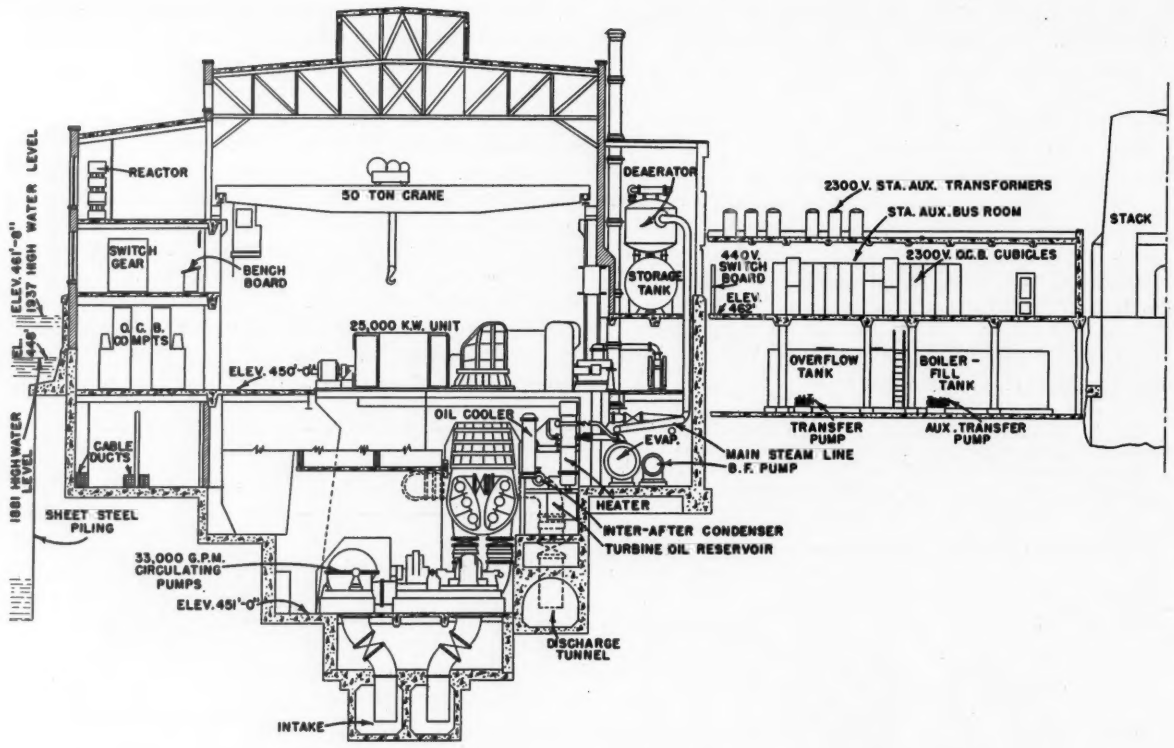
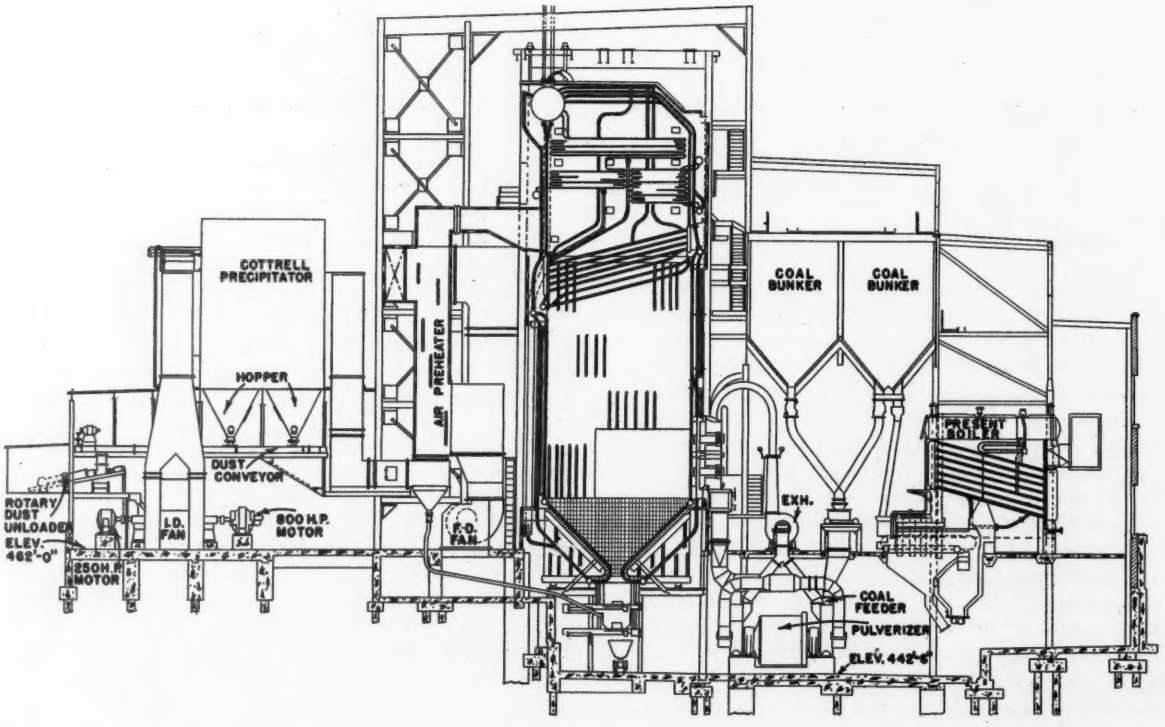


Fig. 4. At the Canal Station of the Louisville Gas & Elec. Co. a new generating unit was put into service last fall to serve as standby for the Ohio Falls Hydro Plant during peak load periods. Low first cost and dependability were prime considerations. The turbine room cross section, above, shows the new 25,000 kw. turbine set over a 27,250 sq. ft. condenser. Cooling water is taken from the Louisville-Portland canal and the condensing equipment is adequate to carry full load with 85 deg. F. intake temperatures. The single boiler, shown by the cross section below is designed to produce 350,000 lb. of 475 lb. 750 deg. F. steam per hour. It is fired by pulverized coal and is equipped with an economizer, air heater and electrostatic precipitator. The induced draft fan discharges through a horizontal duct to the stack shown at the right of the upper drawing



cost and dependability. The principal steam generating station of the Louisville Gas & Electric Co. at Waterside had no space available and, accordingly, the new capacity was installed in the existing Canal Station. A 25,000 kw., 0.70 p.f. Westinghouse turbo-generator was installed, as shown by Fig. 4. This unit is served by a single Babcock & Wilcox high head steam generator designed to produce 350,000 lb. of steam per hr. at 475 lb., 750 deg. F. Existing circulating water tunnel facilities were used, with water taken from the Louisville-Portland Canal. Due to possibilities of recirculation, condensing equipment was installed, adequate to permit carrying full load with 85 deg. F. circulating water. The Ross condenser is an all welded design with cast iron water boxes. It contains 27,250 sq. ft., is of the single pass, divided water box type, and is fitted with $\frac{7}{8}$ in. O. D. 24 ft. long tubes. Two circulating pumps are used, with a total capacity of 65,500 g.p.m., one pump being adequate for the requirements with favorable circulating water temperatures.

The steam generator, Fig. 4, is fitted with an all water cooled furnace, with a volume of 21,385 cu. ft. The boiler portion is of the straight tube, forged steel header type, with 9,440 sq. ft. of heating surface. The superheater is of the continuous tube type, with 6,200 sq. ft. of heating surface, and is fitted with a bypass damper. An 13,540 sq. ft. economizer of the continuous tube type and a 37,700 sq. ft. air heater of the tubular type are included.

All gases and air are handled by vane-controlled Sturtevant fans, with the gas taken through a Cottrell precipitator to remove suspended dust. The boiler is fired by two Foster-Wheeler double ended pulverizers, each having a capacity of 17,000 lb. of Western Kentucky coal per hour and the installation is completely equipped with Bailey automatic combustion control.

The turbine is arranged for bleeding at five points, two of which are used for feedwater heating in closed type heaters, and one for feedwater heating in a Cochrane deaerator. The fourth point is used in connection with a Foster-Wheeler evaporator for supplying make-up to the plant, while the fifth and highest point is not used at present, but is available for bleeding steam to the old plant steam header, should this be necessary.

San Diego Consolidated Gas & Electric Co.—Station "B"

At Station B, space was available for one more unit. As circulating water tunnels, which are under public streets, could not be altered at reasonable expense, it was decided to install as large a unit as possible with the tunnel capacity and space available in turbine room. Hence, a 35,000 kw., 1800 r.p.m., G.E. turbo-generator was chosen, with a 38,350 sq. ft. Worthington condenser using 39,600 g.p.m. of circulating water. An 1800 r.p.m. unit was selected because numerous parts were in stock at the factory, enabling the manufacturer to make delivery several months sooner than would have been possible for a

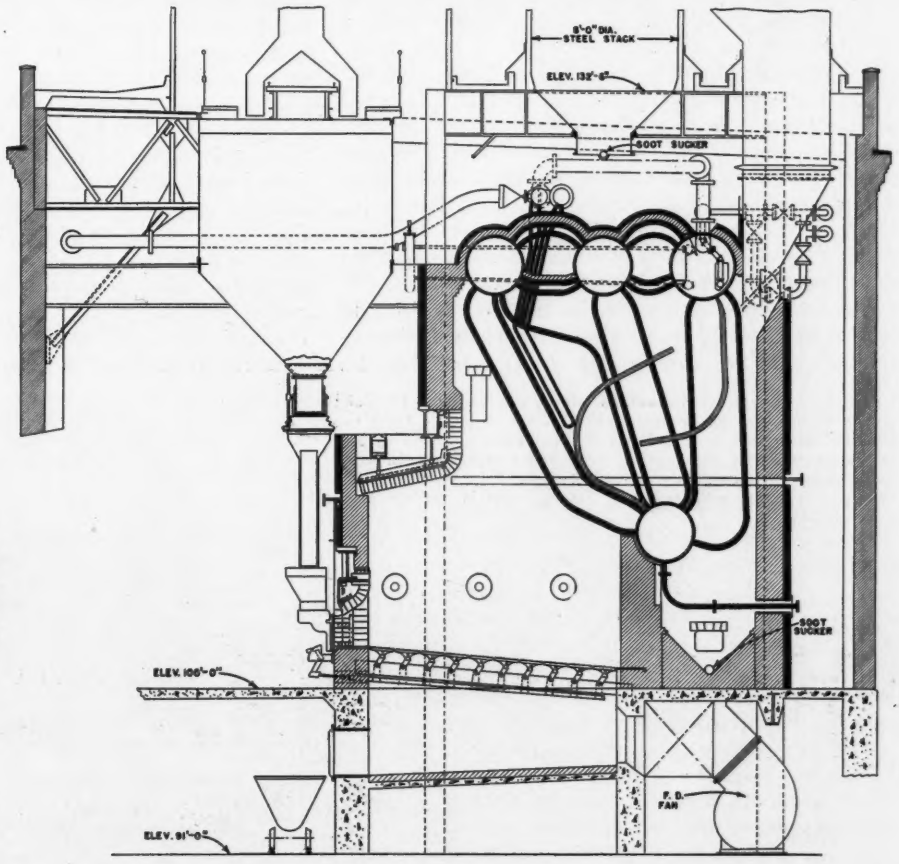


Fig. 5. This new 75,000 lb. per hr. boiler fired with lignite by sprinkling stokers, and, a 3000 kw. turbine unit were placed in service last fall in the Grand Forks Station of the Northern States Power Co.

3600 r.p.m. unit. The equipment was put into commercial operation in March, 1938.

Space for circulating water pumps is limited, and the tunnel branch, serving the last previous unit, cannot be readily shut off from the chamber installed then for supply to the new unit, nor, are low tide periods sufficient to permit extended work without shutoff and unwatering. Therefore, a vertical propeller type circulating water pump was designed to sit over the suction opening already in place, with the impeller and draft tube inserted through this opening to sufficient depth to make the pump self-priming. This pump casing is high enough to permit removal of the impeller and guide vanes without danger of overflow at high tide. A two-speed motor is used to compensate for variations in water temperature which ranges between 55 and 85 deg. F.

As in the previous installation a connection of ample size has been provided, on the circulating pump discharge, ahead of the condenser inlet water boxes, to permit flow direct to the discharge tunnel. This is required because shell fish, sponges and crabs pass the intake screws when small and grow to good size in the tunnel. Experience indicates that a considerable quantity of this material is drawn into the pumps when they are started up after a shutdown, resulting in fouled tube sheets. The bypass mentioned above and shown in the lower left hand corner of Fig. 6 permits sluicing this material directly to the discharge tunnel at each start.

The turbine is bled at the third, seventh and eleventh stages for feedwater heating and a district system as shown by Fig. 3. The eleventh stage serves a closed heater, the seventh stage furnishes some steam to the deaerator, and the third stage serves a closed heater and the district heating system under normal turbine loads. With maximum load on the turbine, the high pressure heater and district heating system can be changed over to the seventh stage to avoid excessive pressure and to gain some economy. The motor operated valves used in this change-over are electrically interlocked so that at no time can the third and seventh stages be open simultaneously.

As this unit is thought to be the final addition to Station B, it is designed for the existing steam pressure and temperature, namely 235 lb. ga., 725 deg. F., 1½ inch back pressure. Due to this choice of pressure and temperature, the boilers installed were made large enough to care for the new generating capacity and also to relieve the deficiency in steam capacity of the existing plant.

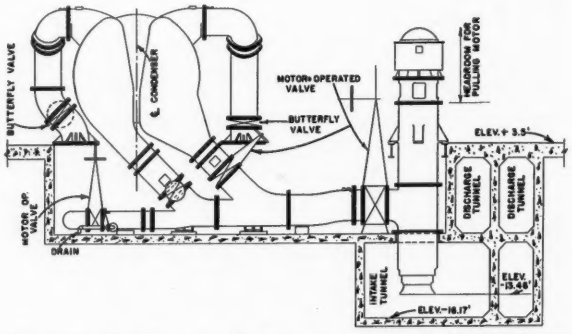


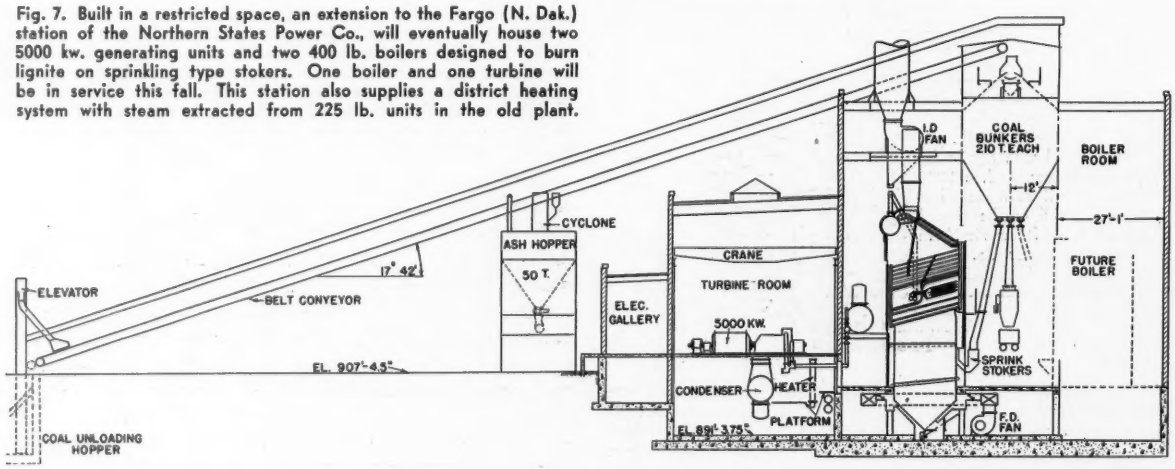
Fig. 6. Circulating pump and piping arrangement used at Station B to solve a difficult problem of limited space and an existing tunnel system

Two B. & W. integral furnace type boilers with air heaters were installed, each capable of producing 200,000 lb. of steam per hr. continuously when fired by natural gas or oil with forced and induced draft. Fans are located over the boilers and are regulated by the combustion control apparatus from panels on the main floor near the burners.

The deaerator receives steam from the auxiliary exhaust supplemented by bleed from the 7 stage, which is controlled to maintain one-half pound gage in the deaerator. All auxiliaries furnished with the new unit are motor driven, as the existing plant had an excess of exhaust steam.

An interesting construction detail resulted from the use of a 35,000 kw. unit, since piling and foundation were already in place for a smaller unit. These were placed within the original cofferdam when the last previous unit was installed. As low tide elevation is about 3½ ft. above the floor of the hotwell pit, and high tide 4 ft. above the basement floor, the driving of additional piles would have entailed excessive costs. Instead, steel caissons were sunk (through tubes sealed to the floor) and filled with concrete when down to grade.

Fig. 7. Built in a restricted space, an extension to the Fargo (N. Dak.) station of the Northern States Power Co., will eventually house two 5000 kw. generating units and two 400 lb. boilers designed to burn lignite on sprinkling type stokers. One boiler and one turbine will be in service this fall. This station also supplies a district heating system with steam extracted from 225 lb. units in the old plant.



Metal Spraying

METAL SPRAYING has been used to considerable extent in power plant practice of recent years to protect equipment against corrosion, oxidation and erosion or to build up worn and eroded parts. The process consists of spraying finely divided metallic particles onto a surface that has been thoroughly cleaned and prepared so that the sprayed metal makes a good bond with the original metal. This bond is purely mechanical. Figure 1, a microphotograph of a zinc coating sprayed on mild steel, shows the irregularities which, on properly prepared surface, serve as anchors for the sprayed coating.

Surface preparation consists of premachining, sandblasting or the use of a roughening or abrading tool. A. V. Gruber of the Metal Spray Division of the Condenser Service & Engineering Co. calls attention to the fact that, in order to obtain maximum adherence, surface preparation for metal spraying should not be confused with the ordinary type of sandblasting for cleaning or preparation for painting. Special tools and grinding wheels should be used with the various types of metals and the finishing should be done at given rates of speeds, feeds and cuts.

If properly used, the process is successful for building up worn or new mechanical, rotating, sliding or reciprocating equipment, for protecting surfaces with noble metals to resist acid, alkali, gas, heat, corrosion or abrasion, and for effective decorative surfaces on practically any type of material such as steel, wood, paper, cloth, glass, plaster-paris or for producing electrical conducting surfaces on di-electric materials. He states, however, that it is important to know the limitation of metal spray because it is not a cure for all evils.

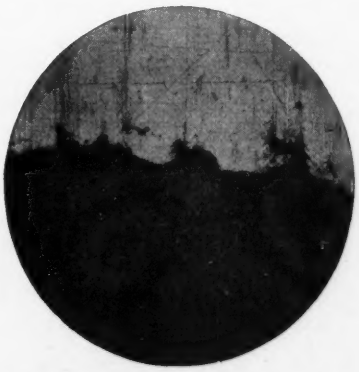


Fig. 1. 300X photomicrograph of zinc (dark section) sprayed on mild steel. The bond between the two metals is mechanical and depends upon anchors and surface irregularities on the original metal surface. This emphasizes the necessity for careful surface preparation before spraying

Metal spray practice at Ashley Street Station of the Union Electric Co., St. Louis, is discussed in an article by M. D. Dawson in a recent issue of the Union Electric Magazine. The water screen side wall headers on all pulverized coal-fired boilers at Ashley Street Plant were protected with aluminum. These headers are subjected to severe sulphuric acid corrosion and could not be protected by painting. Had it not been possible to protect these headers with sprayed aluminum, an expensive job of replacement would have been necessary. There are numerous other jobs of metal spraying and Fig. 2 shows an operator at Ashley Street Station spraying the impeller from a 20,000 g.p.m. pump with Monel metal for protection against corrosion and erosion. The operator is wearing a mask as precaution against inhaling the atomized metal suspended in the surrounding atmosphere. The metal used depends upon the surface and the conditions of operation. For example, aluminum is used to resist heat and acid corrosion, zinc to resist cold and warm water corrosion, and, where there is no acid, Monel metal is used to resist corrosion and erosion.

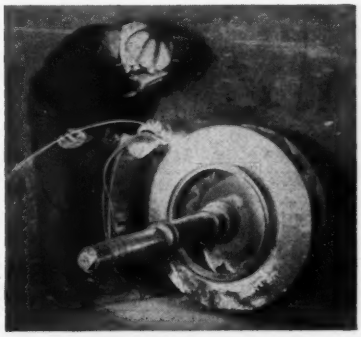


Fig. 2. Building up a 20,000 g.p.m. pump impeller at Ashley Street Station by metal spray

Heating Controls

APPLICATION of controls to heating systems is increasing rapidly and their function, cost and results were made the subject of a report by V. B. Ingram, New York Steam Corp., to the Commercial Relations Committee of the N.D.H.A. The controls investigated covered only central station steam customers and the cost varied from 100 to $10,000. Data was presented on some 61 buildings using from 59 to 6455 lb. per degree day before the installation of controls. Adding controls decreased the average total consumption some 13.5 per cent. The greatest saving was 54.6 per cent. Out of 61 installations, only six showed no savings from the control systems; the worst of these six was an increase of 13.7 per cent. Reasons for the increases are not given but probably resulted from an improvement in substandard heating conditions.

Diesel Engine Maintenance

Maintenance activities vary with the size and personnel of an organization and can be determined only by individual needs. No plan to cover all cases can be given but the experience of one large company as outlined by the author before the Oil & Gas Power Meeting of the A. S. M. E. contains a world of information much of which can be put to practical use.

By E. R. SPICER

Assistant Chief Engineer
Texas Pipe Line Co.
Tulsa, Okla.

DIESEL ENGINE MAINTENANCE programs have received much attention during the past decade. The opinions developed have been varied and conflicting. In actual practice one will find many maintenance plans ranging from the "fix it when it breaks" idea to a very finely worked out system of inspections so complex as to be of questionable economic value.

It is not, however, the purpose of this paper to justify any particular maintenance schedule or program. On the other hand the writer will endeavor to point out and discuss a few factors that are essential to the success of systematic maintenance efforts, regardless of how meager or how broad the scope.

John Doe - Type ZK-Vertical
600 H.P. 5-K-35W

EXHIBIT "A"

ENGINE MAKE & NO. No. 2155E54 PUMP MAKE & NO. Move-more 6-3/4 x 24 Hor. Trip. No. 525699

			CYL. No. 1	CYL. No. 2	CYL. No. 3	CYL. No. 4	CYL. No. 5	CYL. No. 6
MAIN CYLINDERS	CYLINDER HEAD	Condition Repaired or Replaced	Good	Good	Good	Good	Good	
		Head Clearance Before and After Adj.	.368 | .368	.355 | .370	.360 | .378	.345 | .376	.364 | .364	
		Compression Pressure Before and After Adj.	485 | 485	475 | 490	477 | 487	466 | 490	496 | 496	
	LINER	Condition Repaired or Replaced	Good	Good	Good	Good	Good	
		Measurement at With Pin	17.531	17.524½	17.525½	17.520½	17.518½	
		Top of Ring Travel Crosswise of Pin	17.521	17.519	17.519	17.513	17.516½	
		Measurement at With Pin	17.508	17.506	17.506½	17.507½	17.507½	
		Lower Ring Travel Crosswise of Pin	17.506	17.507	17.506	17.505	17.507	
	PISTON	Condition	Good	Good	Good	Good	Good	
		Number of Rings Found Stuck	2	2	3	3	2	
		Number and Size New Rings	5- 17½ x .3712	5- 17½x.3712	3-17½ x .3712	4- 17½ x .3712	4-17½ x .3712	
	CROSSHEAD PIN OR PISTON PIN AND BEARING	Pin Wear (Out of Round)	.001	.003	.002	.004	.001	
		Repaired or Replaced (Diameter)		Ground		Ground		
		Condition of Bearing	Good	Broken	Good	Broken	Good	
		Repaired, Replaced, Clearance	.002½	Rerun | .002	.002½	Rerun | .002	.002½	
	EXHAUST VALVE AND CASING	Condition Valve and Seat	Good	Good	Good	Good	Good	
		Cleaned and Repaired. Show Date	2-11-38	2-11-38	2-11-38	2-11-38	2-11-38	
	INTAKE VALVE AND CASING	Condition Valve and Seat	Good	Good	Good	Good	Good	
		Cleaned and Repaired. Show Date	2-11-38	2-11-38	2-11-38	2-11-38	2-11-38	
	SPRAY VALVE	Condition Valve and Seat	Good	Slightly Carboned	Fair	Good	Slightly Carboned	
		Timing Found—Degrees Open & Close	6°BTC | 36°ATC	4°BTC | 36° ATC	8°BTC | 34° ATC	6°BTC | 36°ATC	6°BTC | 36°ATC	
		Timing Set—Degrees Open & Close	6°BTC | 36°ATC	6°BTC | 36° ATC	6°BTC | 36° ATC	6°BTC | 36°ATC	6°BTC | 36°ATC	
		Valve Lift—Before and After Adj.	.125" | .148"	.121" | .150"	.115" | .146"	.123" | .150"	.119" | .147"	
		Repaired, Reground or Renewed. Date	2-11-38	2-11-38	2-11-38	2-11-38	2-11-38	
	STARTING VALVE	Condition When Inspected	-	-	-	Good	Good	
		Cleaned, Ground or Renewed	-	-	-	2-11-38	2-11-38	
	FUEL PUMP AND FUEL PUMP VALVES	Condition Pump Valve Body	Good	Good	Good	Good	Good	
		Check Valves—Ground or Renewed	Ground	Ground	Ground	Ground	Ground	
		Plunger—Repacked or Renewed	-	-	-	-	-	
		Discharge Valves—Ground or Renewed	Ground	Ground	Ground	Ground	Ground	
		Suction Valves—Ground or Renewed	Ground	Ground	Ground	Ground	Ground	
CRANKSHAFT AND CRANKSHAFT BEARINGS	MAIN BEARINGS	Condition Before & Clearance	.008 | .008	.012 | .008	.010 | .007	.007 | .007	.008 | .008	.009 | .009
		After Adj. Level	Level	Level	Level	Level	Level	Level
		Reset or Renewed	-	- Bottom shell cracked		-	-	-
		Bridge Gauge Crankshaft Free & Clamped	18.175½ | 18.176 ½	18.054½ | 18.055 ½	18.007½ | 18.008½	17.809½ | 17.810½	17.920½ | 17.921½	18.011½ | 18.012½
	CRANK BEARINGS AND PINS	Clearance—Before & After Adj.	.010 | .007	.009 | .006	.010 | .007	.009 | .006	.009 | .006	
		Reset or Renewed	Reset	Reset	Reset	Reset	Reset	
		Crank Pin Condition	Tood	Good	Good	Good	Good	
	DISTANCE BETWEEN CRANK WEBS	Crank at Top Dead Center	.398½ | .397½	.156½ | .155½	.429 | .429½	.516½ | .515½	.540½ | .538½	
		Crank Horizontal—Down Stroke	.397½ | .397	.155½ | .154½	.428½ | .428½	.515½ | .515	.539½ | .538½	
		Crank at Bottom Dead Center	.396½ | .396½	.153½ | .153½	.429 | .428	.515½ | .514½	.540½ | .539½	
		Crank Horizontal—Up Stroke	.397½ | .397	.155½ | .154½	.428½ | .429	.516½ | .515	.541 | .539½	
OTHER BEARINGS	CAM SHAFT	Condition—Reset or Renewed	Good condition - All bearings checked			REMARKS: Pump center crank web readings		
	Vert. or Lay Shaft	Condition—Reset or Renewed	Good Top .012 Adj to .004 Bt .006 Adj to			Before Adj.		After Adj.
	OUTBOARD BEARING	Condition and Level	Before Adj. Level	After Adj. Level .003		A-Top 6.017½		6.015
		Bearing Reset or Renewed—State Clearance	Before Adj. .008"	After Adj. .008"		B-Hor. down stroke	6.015	6.015
	END THRUST IN INCHES	Crankshaft	Before Adj. .011"	After Adj. .011"		C-Bottom	6.013	6.015
		Camshaft	Before Adj. .006"	After Adj. .006"		D-Hor. up stroke	6.015	6.015
		Vertical Shaft	Before Adj. .008"	After Adj. .008"				
GOVERNOR		Cond.; Rods, Pins, Bearings						
		Note Adjustment or Replacements	Renewed Anchor Pins and Bushings					
		Gear Clearance	Before Adj. .014	After Adj. .014				
		Camshaft Gear Clearance—Top & Bottom	Before Adj. .010 - .012	After Adj. .010 - .012				

As in every other activity the proper leadership of a maintenance organization is paramount. First of all, the individual who is to direct activities so involved, should have a very intimate knowledge of engineering fundamentals. It is essential that his imaginative and creative powers are developed to a high degree. These powers must be shot through with the practicability factor.

Forming maintenance policies is not a task for a novice. It is a place for one with a wealth of experience; one having the ability to remould that experience and apply it to existing problems. Another essential prerequisite is a generous supply of the spirit of cooperation. He must be able to work in harmony with other departments. The good will of the operating division must be maintained. The inherent common interest makes cooperation between these two organizations imperative. He must demand cooperation from his subordinates by exhibiting the commendable attribute when dealing with them. It is also important that he should train and help to improve the skill and knowledge of those individuals working under his supervision.

Table II. Mechanical Breakage Report which is filled out at the time of each mechanical failure

No. VX-2

DESCRIPTION OF EQUIPMENT INVOLVED: Exhaust valve cage on "Whip Special" Diesel engine—900 hp., Type XYZ, No. 489, 4 cylinder.

WHAT HAPPENED: Upon investigating loud leakage of exhaust gases and loss of power in the engine, an exhaust valve cage on No. 4 cylinder was found broken between the spring housing and the bolt hole in the fastening lip of the cage.

CAUSE: The breakage is attributed to uneven tightening of the cage together with too much force on the nuts that hold the cage in its port.

HOW REPAIRED: Installed new exhaust valve cage and gaskets.

STEPS TAKEN TO PREVENT RECURRENCE: When tightening valve cages great care is emphasized to make sure that the nuts are tightened with the proper wrench using no wrench extension. Soft compressible gaskets will be used in order to prevent leakage without excessive tightening of the cages.

COST OF REPAIRS: Labor $X.00
DATE REPORT MADE 2-27-37.
DATE BREAK OCCURRED 2-25-37.
MATERIAL $XX.00.
STATION Piney Hill Station.
BY B. H. Johnholtz, Engr.

Form P.-87 (5-36) 7M

MECHANICAL MAINTENANCE REPORT

STATION Pumpkin Center Ridge UNIT NO. 1 DATE February, 1938

					HIGH STAGE		INTER. STAGE			LOW STAGE			
COMPRESSOR	PISTON AND LINER	Condition—Replacement			Good		Good			Good			
		Head Clearance—Before & After Adj.			1/16	1/16	3/16	3/16		1/16	1/16		
		Max. Liner Dia.—Perp. & Par. to Crank			2.757	2.756½	10.756	10.752		12.630	12.629		
	RINGS	Number; Found Stuck; Replaced			None	8	1	1		None	4		
	SUCT. VALVES	Cleaned, Ground, Renewed, Show Date			2-10-38		2-10-38			2-10-38			
	DISCH. VALVES	Cleaned, Ground, Renewed, Show Date			2-10-38		2-10-38			2-10-38			
	AIR COOL COILS	Cleaned, Repaired, Renewed, Show Date			2-10-38		2-10-38			2-10-38			
		Pressures Last Day of Month			900#		150#			60#			
					LEFT		CENTER			RIGHT			
MAIN PUMP	MAIN BEARINGS	Levels—Condition											
		Renewed, Repaired or Adjusted											
	PINION BEARINGS	Levels—Condition											
		Renewed, Repaired or Adjusted											
	CRANK PIN BEARINGS	Condition											
		Renewed, Repaired or Adjusted											
	CROSSHEAD AND PIN BEARINGS	Renewed, Repaired or Adjusted											
		Crosshead Adjusted or Repaired—Cond.											
	PUMP CHAMBER	Renewed or Repaired											
					LEFT SIDE				RIGHT SIDE				
	PUMP GEAR	Clearance—Before & After Adj.											
		Condition—Before & After Adj.											
	PLUNGERS		Left Crank	Left Crank	Center Crank	Center Crank	Right Crank	Right Crank					
		Condition											
		Renewed or Repaired											
		Packed—Kind & Date											
	VALVES AND SEATS	Condition											
		Repaired or Replaced											
	COUPLING	Clearance	Top	Quarter		Bottom	Quarter						
		Alignment	Vertical			Horizontal							
MISCELLANEOUS	DATE BOLTS TIGHTENED AND INSPECTED		Engine			Pump							
		Foundation											
		Frame											
		Others											
	IDLER GEAR BEARING	Bearing Reset or Renewed											
		Gear Clearance & Cond.											
	LUBRICATING SYSTEM INCLUDING PUMPS	Piping Cleaned & Inspected											
		Lubricator Cleaned & Inspected											
		When Circulating Pump Repaired											
	WATER JACKETS	Date Mud Washed Out and Condition	Main Cylinder		2-10-38 Soft Muddy Scale								
			Cylinder Heads		2-10-38 Thin Scale								
			Exh.—Manifold Cooler		2-10-38 O.K.								

FORCED SHUTDOWNS—ENGINE AND PUMP		
Date	REASON	Hrs.
1	Down for General Overhaul	

REMARKS: This unit ran 12,429-3/4 hrs. between overhauls 6-1-36 and 2-1-38 - Total 1 yr. 7 mo.

OPERATING DATA	
Accumulative Hours Run	36,416
Hours Operated During Month	428
Hours Run Since Last Complete Overhaul	428
Date of Last Overhaul	February 1-11,1938

It is imperative that the individuals responsible for maintenance activities be kept informed as to the mechanical condition and problems encountered on the machinery in their care. This is a relatively simple matter where the engines involved are few in number and all in one plant. On the other hand, however, where there are many units and these scattered over a large area the memory or other hit and miss records cannot be depended upon. A set of systematic and reliable records must then be used to provide authentic information.

The form and frequence of these reports will vary with each organization. The general maintenance plan will, of course, be the greatest single factor in determining the style of statements. Other things such as kind, type, number, and location of engines to be serviced will also influence the form greatly. It is, therefore, beyond the scope of this paper to outline a set of records that will adequately serve any and all Diesel engine maintenance programs. We would, however, like to offer as exhibits, samples of a few record forms that have been developed for one of the large companies. This particular company con-

Table I. Mechanical Maintenance Report made out each month for each engine by the operating engineer in charge and the local machinist. The actual form includes columns for cyls. 7 and 8 (which were eliminated to save space) and the data in the adjoining columns which was reproduced as a separate cut to facilitate makeup

trols approximately 70,000 hp. in Diesel engines. They are scattered over a territory covering eight states. The engines involved are mainly of the heavy duty slow speed type. It is obvious that a maintenance program which will provide adequate and economical service for this large group of engines must be backed up with adequate and authentic records.

Table I is a report developed primarily to give a progressive picture of the mechanical condition of a given engine. It is made out for each engine monthly. The operating engineer in charge and the local machinist cooperate in furnishing information to be indicated. In discussing this exhibit the information covering the main line pump as shown on the form will be disregarded.

At first thought this might appear somewhat cumbersome. A study of the items listed and instructions for its compilation may make it more attractive. It will be noted that the form carries most of the items on which recorded information is essential. Remarks and data are only supplied if and when available. For instance, if the head valves on an engine have not been removed or reconditioned during the current period the columns covering same are left blank. Likewise no bearing clearances are shown unless the actual measurements have been made during the month. It is then conceivable that report forms will be turned in, bearing no mechanical data whatsoever. In such case the form will not have anything on it except the identification and hours of operation. On the other hand the form may carry pertinent information on each item listed.

As an adjunct to the mechanical maintenance report Table II is offered. One of these forms is filled out at the time of each mechanical failure and forwarded to the proper parties. As in the case of the maintenance report this form is filled out by the engineer in charge, with the cooperation of the machinist.

Each of the above reports furnishes current information that is necessary for intelligent day to day planning. The accumulation of these statements supplies a wealth of recorded knowledge which is invaluable.

While the two reports outlined above are of vital importance, they are not the only records required. A periodic statement of fuel and lubricating oil consumption is of material assistance. Such information deals primarily with efficiencies but it furnishes additional criteria by which to judge mechanical conditions. A comparison of monthly statements showing unit quantities of lubricating oil and fuel used is one of the most rapid and sure ways of detecting changes in the state of repair of any individual engine.

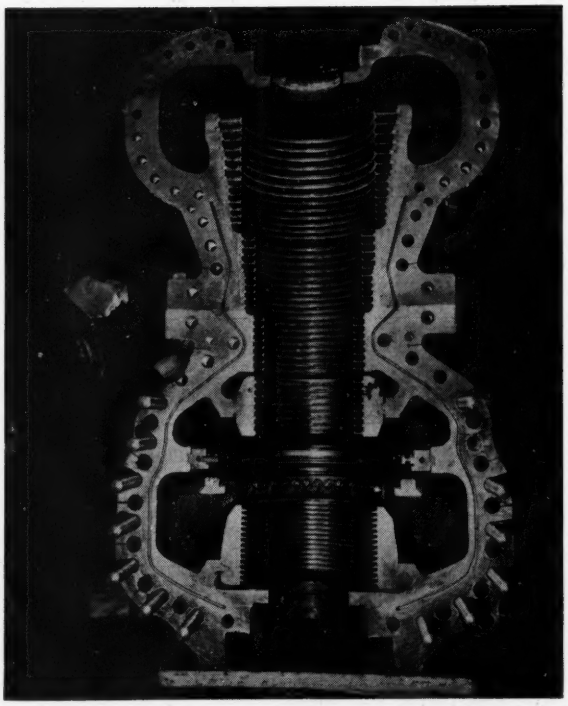
Importance of such information cannot be overestimated. The excessive use of these materials is one of the first warnings of conditions which, if allowed to continue, will do permanent damage to the engine. Thus, a daily record of consumption should be on file at all times.

Regardless of how well organized or how effectively any maintenance program may have been worked out, it can only be justified in terms of actual monetary returns. These returns may appear in many forms, some of the more important are: Less out time; reduced spare parts inventory; lower repair material cost; lower repair labor cost; lower operating cost; increased dependability; increased ability to carry maximum load.

It is, therefore, quite necessary that a detailed cost accounting record be maintained. The type of such records will largely depend upon the industry involved. From the foregoing it is obvious that a complete and effective record system embodying all phases of the work is essential to the success and economic pursuit of any maintenance program.

Turbine Construction

PUTTING the final touches on the upper half cylinder of a 2500-kw., 3600 r.p.m., non-condensing impulse reaction steam turbine in the Allis-Chalmers Works. The higher colored section at the bottom, the high pressure section, is steel and the darker section at the top is cast iron. The grooves in the flange form a dope ring which is filled with a plastic material by means of a grease gun after the flanges are bolted together. The slots from the holes to the edge of the flange are made to minimize local strains due to the difference in expansion between the heavy flange edge and the turbine shell proper and to prevent cracks from starting. These slots are staggered on the flanges of the upper and lower cylinder halves.



Shop view of the upper half cylinder of a modern 2500 kw. turbine

Part XXX

More about the problem of voltage regulation, particularly with respect to voltage regulation in industrial power plants where wide load savings are liable to occur. For this class of service the new electron Tube regulator described in this article has many advantages. It is simple, has no moving parts, is rapid in its action and, compared to other types of equipment capable of accomplishing the same purpose is inexpensive.

ELECTRON TUBES— Principles and Applications

By A. W. KRAMER

THE ART of automatic voltage regulation is almost as old as the history of the electric generator. Almost from the beginning of Edison's first commercial electric system it was evident that some means of automatically adjusting the voltage with variations in load was necessary. As a consequence, the development of the voltage regulator went on simultaneously with that of the art of generation and distribution, but even, years ago, the automatic voltage regulator attained a stage of perfection that was equalled by few other electrical devices. All of us at various times have stood in admiration before the vibrating type regulators as they performed their useful function silently and reliably in power stations all over the world.

The great bulk of credit for the success of the vibrating voltage regulator must always go to Allen A. Terrill after whom it was named. Allen Tirrell died a few years ago unostentatiously as he had lived. When he passed on no newspapers carried headlines of his passing as they would have of a captain of industry or a gangster but that was not necessary. Of a retiring disposition, he seldom talked before societies; he was a worker who when he died left the imprint of his efforts in every electric generating plant in the country. The Terrill regulator has been an inseparable part of every generating plant for over three decades. He succeeded in perfecting the only two generator voltage regulators that proved commercially feasible. For over 20 years the voltage regulator was Mr. Terrill's almost sole thought. The first of his two regulators he sold to the General Electric Co. in 1902 and later when with Westinghoure he designed his second.

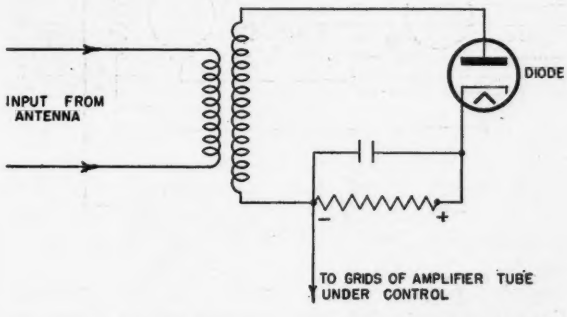


Fig. 1. The fundamental principle involved in the automatic volume control (AVC) system used on modern radio receivers

The point of all this is to emphasize the fact that the vibrating types of voltage regulators as well as other types developed here and in Europe are, and have been highly perfected devices, adequate to meet most requirements. With the advent of the electron tube, a new type of regulator has become possible, but this does not imply that this type will necessarily replace or supersede all of the older types, at least not in the near future. There are a number of simple and inexpensive regulators on the market which are adequate for all ordinary requirements and there is no need for replacing such units with electron tube units which at present at least may be more expensive. Nevertheless, the newer electron tube voltage regulators have advantages which are not inherent in some of the older forms and under certain conditions are less expensive than the older types for the same conditions.

One of these advantages is speed of action. Here, as in practically every other application of the electron tube, the instantaneous response of the tube fits it for almost any function that may be demanded of it. A good example of the tube's ability in this respect, although this is more a case of voltage adjustment than voltage regulation, is in the automatic volume control feature of all modern radio receivers. Those familiar with the "kitchen sink" days of radio

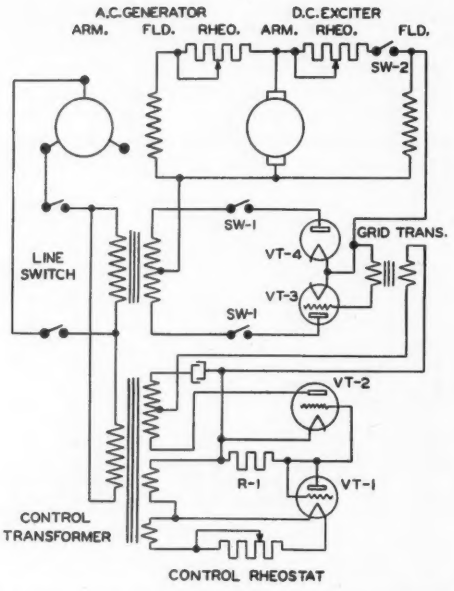


Fig. 2. The circuit of the Ward Leonard electronic regulator

receiver construction, when bank clerks and grocery boys alike who scarcely knew a resistor from an inductance spent what might have been leisure hours building weird contraptions which went by the name of radios, may recall that these sets were unstable in their action. At times the program would come in with deafening volume; then as the signal faded, it would die down to a mere whisper and we would turn up the "volume control." Now, the volume control is merely a variable resistor by means of which the grid bias voltage of the amplifier tubes is varied. On a very strong signal, the grid bias voltage is increased and the plate current and therefore the output to the loud speaker is decreased, lowering the volume of sound. On a weak signal, the volume control is turned so that the grid bias voltage is decreased, with just the opposite effect.

It was annoying to continually have to make this manual adjustment of the volume control, so one of the first refinements to be developed in receiver construction was the automatic volume control system, now universally used on receivers. This system is known as the AVC. With this arrangement the input signals from the antenna are first amplified as much as desired and delivered to a rectifier (detector). In this rectification process, the direct current produced is made to flow through a resistor as shown in Fig. 1. One end of this resistor is naturally more negative than the other. This negative end is connected to the control grids of the various amplifier stages so that strong signals increase the negative bias on the amplifier tubes and weak signals decrease the negative bias. The action is instantaneous and by means of this system the output of a receiver may be maintained constant over input variations of 100,000 to 1 in input voltage.

This, in effect, is the inverse of voltage regulation but the principle involved is similar and it will be obvious that such rapid action is made possible only by a device capable of such rapid control as the electron tube.

We have already considered one form of automatic voltage regulator,[1] but this was a rather specialized circuit using the condenser discharge principle. In the present article we will consider a more conventional system—one developed by Ward Leonard Electric Co. of Mt. Vernon, N. Y.

Before we present the details of this system a brief consideration of the problem of voltage regulation will be of interest, particularly as it applies in industrial and institutional power plants of moderate generating capacity. Such plants present quite a different problem as regards voltage regulation than do large plants —utility stations. The reason for this difference is the very much larger percentage change in kv-a. load during periods of fluctuation in comparison to the generating capacity in service. This usually is due to the inrush current to the largest motor in use and, in severe cases, this may amount to as much as 50 per cent of the rating of the generator.

Motor starting involves a sudden demand for a large amount of additional excitation on the generator field, and as the motor being started approaches normal speed, the excitation required is gradually diminished to the amount required by the total load at the changed operating power factor which usually results.

As the load on a generator varies between rather wide limits it is the duty of the voltage regulator to govern the delivery of the excitation accordingly and with a load of a fluctuating character, this means a continual adjustment of the generator field current. This adjustment should be made as rapidly as possible. If it could be made instantaneously, the voltage regulation would be perfect but in practice certain inherent characteristics of the equipment limit the speed. To begin with, both the generator field and exciter field circuits are highly inductive and thus the current cannot change instantaneously. Secondly, if the exciter is a self-excited machine, the rate of voltage increase in response to a reduction of the resistance of the field rheostat is dependent upon the progressive building-up action—inherent in any self-excited d.c. generator.

[1] September issue, p. 576.

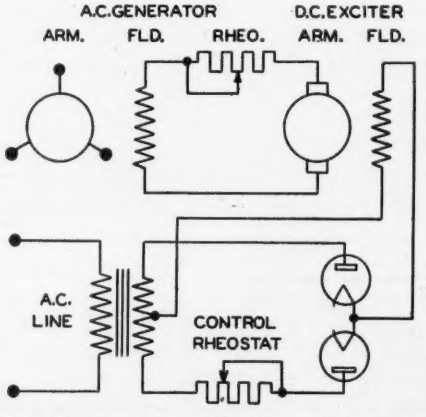


Fig. 3. This diagram shows how the voltage of an a. c. generator could be controlled manually by means of a full wave rectifier and control rheostat

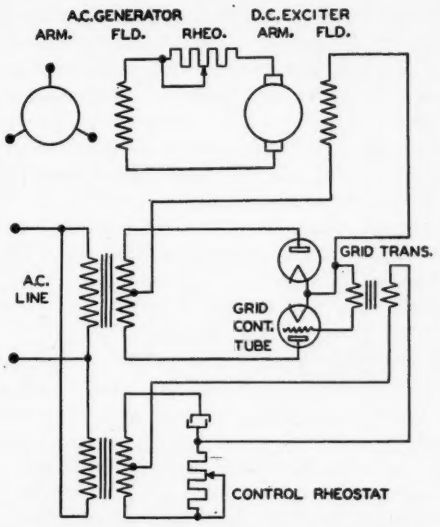


Fig. 4. A further step in the development of the circuit in Fig. 3. Here one of the rectifier tubes is grid controlled, the grid taking the place of the rheostat in Fig. 3. The control, however, is still manual

Finally, a third limit to rapid action is found in the voltage regulator itself. A definite time is required for the regulator to function after the impulse calling for action has been received. Usually this delay is due to the time required for the various mechanical linkages involved to complete their proper motions. In the ordinary inexpensive regulator this may be a matter of 20 to 30 cycles. The very best, and therefore the most expensive regulators available, normally require from 3 to 3½ cycles to start the corrective action.

While it is possible to effect a reduction in the time of action of the process by improving the generator design by the addition of damper windings on the field poles or increasing the physical size of the generator, there still remains the improvement of the regulator itself which requires a large initial expense.

In large generating stations where very large machines are used pilot exciters are often used. These are small direct current generators mounted on the end of the generator shaft together with the main exciter, and provided solely to furnish a steady voltage of proper value to the exciter shunt field. This avoids the delay due to the progressive building-up action inherent in a self-excited d.c. generator, but of course the limitations regarding the regulator still remain.

The development of the electron tube voltage regulator, however, provides a new aspect to the problem and seems to offer a solution at moderate cost. This regulator is extremely rapid in action as it employs no mechanically moving parts and there are no complicated adjustments necessary in its operation and maintenance. Used in combination with a properly coordinated generator and exciter system, it provides a degree and speed of voltage regulation not heretofore possible, except at prohibitive cost.

Essentially, the Ward Leonard regulator consists of a grid controlled gas filled rectifier, deriving its input from the a.c. generator whose voltage it controls, and delivering direct current to the shunt field of the exciter in an amount determined by the a.c. voltage.

The circuit of this regulator is shown in Fig. 2. As shown it is essentially complete except that the "anti-hunting" damping circuits and the automatic switching arrangement used in placing the regulator in and out of service are not shown. The theory of its operation, however, can be explained better perhaps by the simple circuit in Fig. 3 which shows how the voltage of an a.c. generator could be controlled manually using a full wave rectifier and a control rheostat. Even though the control rheostat is placed in the circuit of only one tube, changing the setting of the rheostat will adjust the output of both tubes. This is due to the electromagnetic coupling of the two tubes provided by the high inductance of their common load, the exciter shunt field winding. Therefore, only one rheostat is required to control the output of the entire rectifier circuit. This circuit is simple and requires no particular comment—it is primarily a means for obtaining a source of direct current for the exciter field from the a.c. lines.

Carrying the idea a step further, the circuit in Fig. 4 effects the same purpose but does so by means of grid control of the rectifier tubes. The grid in this case takes the place of the rheostat in Fig. 3. The advantage of this method is that the grid requires practically no power to operate, and can be better controlled by an electrical system than by electromechanical devices. The electrical system consists of a grid transformer supplied by a phase shifting circuit which contains the control rheostat. As in the case of Fig. 3, however, control of the a.c. voltage is obtained only by adjusting the rheostat manually.

Thus, we come to the complete circuit shown in Fig. 2. Here, the a.c. supply for the rectifier (now the

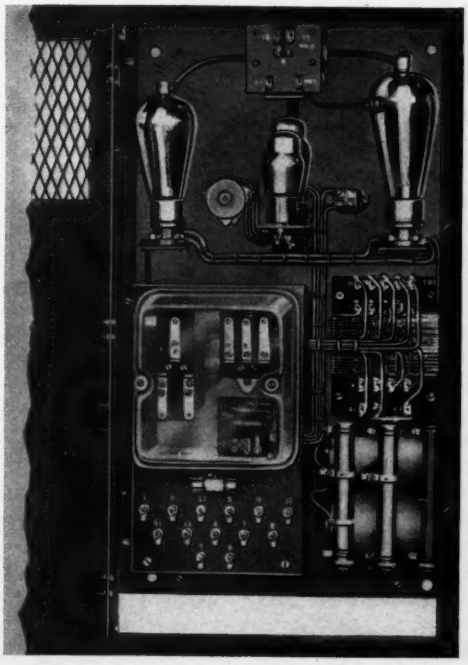


Fig. 5. The Ward Leonard Electronic Voltage Regulator showing the two rectifier tubes at the extreme left and right and the control tubes in the center

regulator) is taken directly from the generator whose exciter the regulator supplies, and the rheostat in the phase shifting circuit has been replaced by an electron tube VT-2.

As it is connected, the function of VT-2 is exactly that of an adjustable resistor. Its resistance is determined by the amount of bias voltage which is impressed on its own grid. This bias voltage is the voltage drop across R-1 which in turn depends on the current which flows from the anode of VT-1.

The anode of VT-1 is operated at plate saturation,[2] that is, the plate voltage is adjusted so high that all the electrons emitted by the heated cathode are attracted to the anode and maximum current flows in the anode circuit. The anode current therefore is entirely a function of the cathode temperature.

Under these conditions the anode current of VT-1 will vary with changes in the a.c. generator voltage. As will be seen, the cathode or filament of VT-1 is energized by a low voltage winding on the control transformer. This in turn receives its power from the a.c. generator. Any small change in generator voltage immediately reflects in the control transformer and this change applied to the cathode of VT-1 immediately changes the cathode temperature and therefore the anode current. Thus within ½ cycle of the change in line voltage the control circuit is put into action to change the output of VT-3 and VT-4 and restore the generator voltage to normal. The operation of VT-1 at plate saturation makes it very sensitive to line voltage changes.

Notice that the function of the control rheostat has changed entirely. In Fig. 4 it was necessary to move the rheostat manually in order to shift the phase of the bias voltage and thus change the regulator output. Now, all this is done automatically. The only function of the rheostat is to determine what generator voltage within a band of 5 per cent of normal the regulator will maintain.

In action the following sequence of events occurs:

1. Assume the a.c. generator load to be decreasing.
2. The a.c. generator voltage increases slightly.
3. The voltage and temperature of the cathode of VT-1 increase.
4. The anode current of VT-1 increases and the drop across the resistor R-1 increases.
5. The negative bias voltage on the grid of VT-2 (which is the voltage drop across R-1) increases and reduces the plate current of VT-2 thereby increasing its resistance.
6. The phase of the grid voltage applied to VT-3 is altered in a direction to decrease the output of both VT-3 and VT-4.
7. The shunt field current of the exciter is reduced, the exciter armature voltage is lowered, the a.c. generator field current is decreased, the a.c. generator terminal voltage is lowered and the system comes back to normal.

This seems a long sequence of events when described in words but electrically it takes place in an amazingly short time.

[2] See Part III, p. 230, April 1936.

In considering the action of this regulator, importance of the separately excited exciter must be understood. If an exciter field is connected to the armature terminals as it is in an ordinary shunt wound machine, the rate of change of field current can be no faster than the rate of voltage change in the armature. If, however, the shunt field is disconnected from the armature and supplied from another source as in this case, this external source can "force" the exciter field to change its current much more rapidly than the armature terminal voltage. "Forcing" the field in turn causes the exciter armature voltage to respond much faster than it would otherwise.

At the present time regulators of this type are available only for comparatively small machines but there is no fundamental reason why they cannot be applied to machines of larger capacities. A number are in use on generators of 2000 and 3000 kw. capacity and larger units can be built. As the price of tubes is reduced, the scope of these devices will undoubtedly be increased.

Thus, as in many other instances, in the field of voltage regulation, the electron tube makes possible a new device without any mechanical moving parts and with a high speed of action that is inherent in all electron tube equipment.

Modern Turbines

(Continued from p. 633)

of steam conditions in which all of the variables have changed as it is to read a TSR in which only one variable has been changed.

Maximum output can be approximated by using formula A-3, which will take into account the correction for exhaust pressure, and will not introduce an appreciable error even though the superheat is changed considerably.

It is interesting to observe that a change in superheat does not affect the load carrying capacity of a turbine. This may seem strange when it is recalled that a drop of 100 deg. F. in superheat may mean the steam rate going up perhaps 8 per cent. But the interesting thing is that the capacity of a turbine to pass steam *is increased with a drop in superheat.* And even though more steam may be required to carry full output with reduced superheat, the turbines' ability to pass steam will increase enough to offset the greater flow, with the result that the load carrying capacity will not be appreciably affected.

From the standpoint of general utility the principles given in this article should be of great value to those closely associated with the selection or operation of steam turbines. Weeks are often spent in lengthy correspondence on questions which could be quickly answered if the simple approximations given in this article were known. And these principles applied to many power plants will give the operator a better understanding of what to expect when conditions change as they seem to do inevitably in almost every Industrial Power Plant.

As engineers, the readers of this publication are quite accustomed to increases in efficiency as the result of new development or technical improvement. But what do you think of a development which at one clean sweep raises the output of a standard device from 0.3 of a unit to 70 units with the same input—an efficiency gain of 200 fold! Startling? Well, this article tells of such a development. The material in it was taken from a paper under the same name presented at the summer convention of the A.I.E.E. in June by G. E. Inman and R. N. Thayer, both of the General Electric Co., Cleveland, Ohio.

Low Voltage Fluorescent Lamps

IT IS rather a strange paradox that our most useful electrical device as well as one of the most highly developed is also the most inefficient. Few devices used in the electrical art are more universally used than the electric lamp, in particular the incandescent lamp; yet the efficiency of the 40 watt filament lamp, for example, at best is only 7 per cent. Ninety-three per cent of the energy supplied to it is wasted insofar as light is concerned. Small wonder then that the so-called "cold" light of the firefly or glow worm has intrigued the fancies of scientists and laymen alike for years.

The lamps described in this article are not "cold" lights in the literal sense of the word, but they are so much colder than the conventional incandescent lamps that the term is not without significance.

These lamps are the result of many years of investigation in three fields, i. e., the production of ultra-violet radiation, the development of hot cathodes in vacuum tubes and the production of efficient fluorescent powders. For some time it has been known that certain chemical substances fluoresce when exposed to the action of invisible ultra-violet radiation. This production of luminous radiation from invisible radiation is a frequency conversion process—a sort of superheterodyne action applied to light. High frequency (ultra-violet) radiation acting upon the atoms of certain chemical substances so excite these atoms that they in turn radiate lower frequency radiation—radiation whose frequencies lie within the visible range.

This, then, is the fundamental principle of these lamps. Ultra-violet radiation produced by a mercury arc discharge in a glass tube, causes certain chemical coatings on the inside walls of the tube to fluoresce and thus become luminous. This luminosity is the source of the visible light emitted by these lamps.

In construction they are very simple. As shown in Fig. 1 the assembled lamp consists only of this coated tube and a sealed-in electrode at each end. In manufacture, the tube is first evacuated; then a little argon gas is introduced and a small drop of mercury admitted and the tube sealed. The result is a white glass tube with a cap at each end, far more rugged than the conventional filament lamp of the same size and shape (the standard Lumiline lamp).

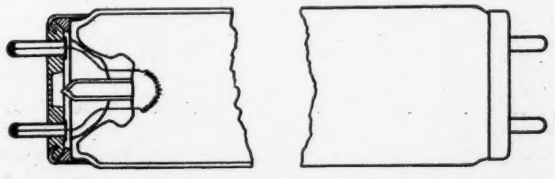


Fig. 1. Construction of a fluorescent lamp. The left of the diagram represents the cross section of an end. The right of the diagram shows the external appearance. Both ends are identical

The argon is introduced to facilitate starting the arc. Mercury at normal temperature is a liquid and before the mercury vapor can become effective, the drop of mercury must be evaporated. The argon, however, remains a gas at normal temperatures. Therefore, by introducing a little argon, the arc starts as an arc in the argon gas and as this heats up the drop of mercury is vaporized which then serves to conduct the current.

TABLE I

Characteristics of Some Fluorescent Lamps

Length	Diameter	Watts	Volts	Amperes	Approx. lumens per watt of a green lamp
18 in.	1 in.	15	63	0.27	60
18 in.	1½ in.	15	50	0.33	60
24 in.	1½ in.	20	65	0.35	65
36 in.	1 in.	30	115	0.30	70

The electrodes are small coils of tungsten wire coated with emission materials, barium or strontieum carbonates, which in the manufacture of the lamp are decomposed into oxides. This is exactly as in radio tube manufacture. The tungsten wire is small enough not only to be heated sufficiently by the energy of the discharge to provide good emission but also to heat up quickly when the lamp is started.

The inner wall of the tube is coated with a thin layer of fluorescent material. Inside coating in addition to its usual advantages is essential in this case because the ultra-violet radiation which excites the fluorescent material will not pass through ordinary glass. The coating must be thick enough to absorb the impinging ultra-violet, yet thin enough in every section not to absorb too much of its own light, or light internally directed from the opposite side of the tube. Considerable effort has been spent on the technique of obtaining coatings smooth and uniform in appearance and lamps of uniform color and efficiency.

Mercury is used as the vapor for the discharge in

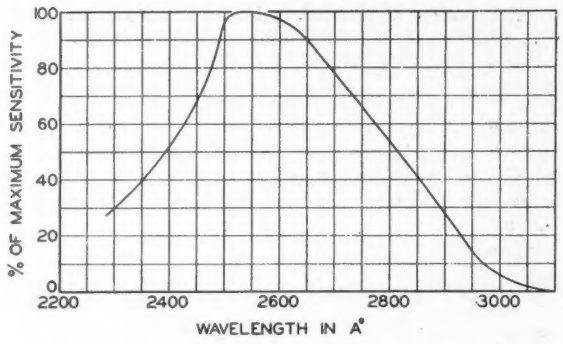


Fig. 2. The relative sensitivity of the zinc beryllium silicate phosphor to ultra-violet radiation of various wave lengths. The peak at or near λ2537 A° is characteristic of several fluorescent materials

these lamps because of its high efficiency in producing ultra-violet radiation of one wave length, its resonance line being λ2537 A° (Angstrom Units). In the 15-watt fluorescent lamp 50 per cent of the energy supplied to the lamp is converted to radiation of this frequency. Consequently, in the development of these lamps, fluorescent materials have been selected which will produce light most efficiently for ultra-violet radiation of this frequency. (Fig. 2) No other measured spectral line of the low pressure discharge in mercury vapor amounts to more than 2 per cent of the input energy. Hence, the λ2537 A° line can reasonably be considered as the chief exciter of fluorescence in these lamps.

Temperature is a critical factor in the efficiency of production of λ2537 A° in these lamps. This efficiency is highest at 40 deg. C. as shown by Fig. 3. Consequently a lamp at the most efficient temperature will run only 15 to 20 deg. C. hotter than normal room temperature. Lamps must run hotter than this optimum point to obtain higher wattage and higher light output in tubes of the same dimensions.

Another design factor is the lamp voltage. There is an almost constant voltage drop at the electrodes which is practically lost as far as ultra-violet and light production is concerned. Consequently, the higher the lamp voltage is raised by increasing length or decreasing diameter, the smaller in percentage this loss becomes. It is quite possible to make a lamp of the bulbular shape similar to that of incandescent lamps but the cathode drop in such lamps becomes a large

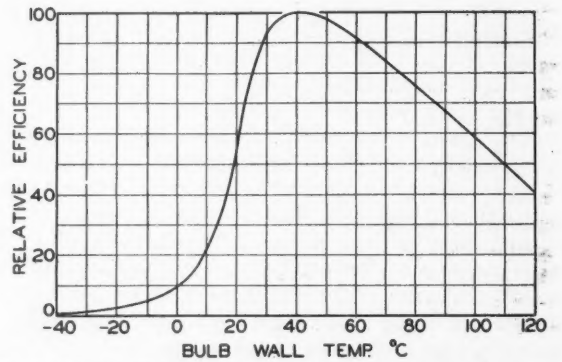


Fig. 3. Relative efficiency of production of mercury reasonance radiation λ2537 A° vs. bulb temperature, for the positive column of a mercury discharge at 0.25 amp. in a tube 1 in. in diameter. The fluorescent light output follows this curve closely

TABLE II

Approximate Energy Utilization in a 15 Watt Fluorescent Lamp	Efficiency of Process
Conversion to 2537 A°	50%
Quantum conversion of 2537 A° to visible radiation (5100 A°)	50%
Perfection of fluorescent material	60%
Transmission of envelope	90%
Overall efficiency	13%

percentage of the total drop and the luminous efficiency is low.

The hot cathodes of course facilitate starting. The starting voltage of a fluorescent lamp without preheating the electrodes is about four times the operating voltage. With sufficient electrode preheating, the required starting voltage may drop to 115 v.

In the use of these lamps, the electrode design is so correlated with external reactors that the electrodes are heated to incandescence when the switch is closed. This is most easily explained by Fig. 4A. Opening the switch by hand, or automatically by a thermal switch after one or two seconds of heating, produces a surge from the reactor which easily starts the discharge.

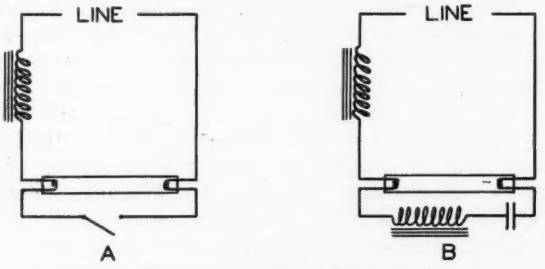


Fig. 4. Operating circuits for fluorescent lamps

Another circuit, the semi-resonant circuit developed by M. A. Edwards of Schenectady and shown in Fig. 4B, provides simultaneously some voltage boost and electrode heating current, low wattage loss and automatic action with no moving parts. As soon as the lamp starts, it effectively shunts the parallel circuit, and runs at an operating current determined by the series unit. The energy lost in the parallel circuit is less than 1 watt. The whole circuit consumes 17 to 18 watts overall for a 15 watt lamp.

The power factor of most fluorescent lamp circuits is closely given by the ratio of the lamp to line volts. A 65 v. lamp on the circuit shown in Fig. 4A with 115 v. line, gives about 0.57 lagging power factor.

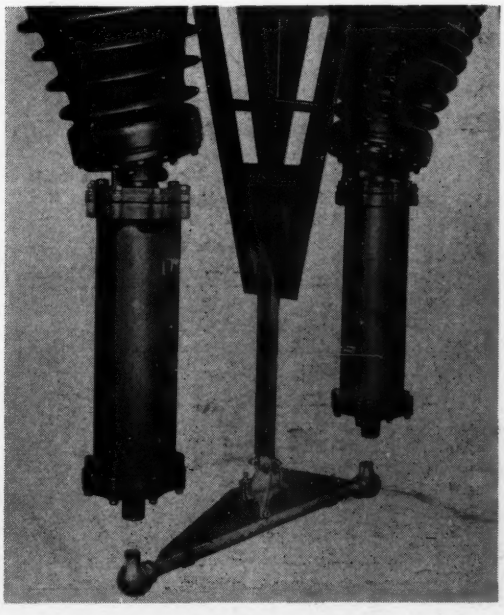
The outstanding advantage of the fluorescent lamp is its ability to produce colored light at efficiencies far exceeding those of filament lamps. Experimental 15 watt green fluorescent lamps have operated at 70 lumens per watt, compared with about 0.3 lumen per watt for 60 watt filament lamps, an efficiency gain of about 200 fold. In blue, corresponding efficiencies are 18 against about 0.3, a gain of about 50 fold. In other colors the gain is less spectacular but still several fold. Fifteen watt fluorescent lamps of the same color as daylight have been made with efficiencies of about 30 lumens per watt, to give 450 lumens. Obtaining the same amount of light from a filament lamp with a suitable absorbing filter requires about 150 watts, i.e. 10 times as much wattage and heat.

New Interrupter Speeds Circuit Breaker Action

A FASTER operating time for many conventional tank-type oil circuit breakers now in use can be achieved through application of a new multibreak interrupter developed by the General Electric Company. Recently subjected to interrupting tests on 138 kv. and 230 kv. systems, the new device consistently cleared short circuits as high as 2,000,000 kv-a. in less than 5 cycles. In each series, carbonizing of the oil and erosion of the contacts were very moderate in spite of the fact that these tests are believed to be the most severe yet made on a high-tension circuit breaker.

The new multibreak interrupter utilizes the oil blast principle. Pressure created by the arc forces oil across the arc and out through ports in the cylindrical housing. This principle is responsible for the new interrupter's ability to obtain performance, on circuit breakers of the conventional type, that approaches the impulse designs for voltages of 115 kv. and above. The tests of the new interrupters disclosed that six breaks per terminal for 230 kv. applications, and four for 138 kv. service, were adequate.

The interrupter is contained in a thick-walled, cylindrical housing of insulating material of high dielectric and mechanical strength. As the housing is easily removed, contact parts may be readily exposed for inspection.



Close up of the new high speed interrupter

Stationary members of the conducting parts are supported on four vertical insulating posts, each fastened at the top to the upper cover of the interrupter, and at the bottom to a retainer. Extending through the center of the interrupter is an insulating rod which carries the moving contacts. The rod terminates in a metal cap which is the contact engaged by the crosshead, and a flexible lead carries the current from the cap to the main current path of the interrupter. The contacts are faced with an arc-resisting copper alloy; heavy and uniform pressure on each pair is maintained by a spring inserted between each contact and the center operating rod.

The new interrupter and the tests were described in two papers presented at the summer convention of the AIEE. One, by R. M. Spurck and H. E. Strang of the General Electric Company, was titled "A New Multibreak Interrupter for Fast-clearing Oil Circuit Breakers." The other, "Tests on and Performance of a High-speed Multibreak 138 Kv. Oil Circuit Breaker," was delivered by Philip Sporn and H. P. St. Clair of the American Gas & Electric Co.

Breakers equipped with the new interrupters and having an interrupting time rating of 5 cycles are available in ratings of 115 kv. and upward. Existing round tank breakers of voltage ratings of 115 kv. and upwards may be modernized to 5-cycle interrupting time by the application of these interrupters.

"Cut Expenses"—Says the Boss

EVERY TIME there is a depression the General Manager calls in the Plant Superintendent and tells him that he is sorry but it is necessary to cut down on expenses. The Plant Superintendent usually tries to protect his personnel as best he can and starts to dig around in other quarters to get the saving the "Boss" has asked for. He begins to think what he can do with this machine or that motor, or what could be done in saving on the power bill, and many other points that have been combed and recombed for economy.

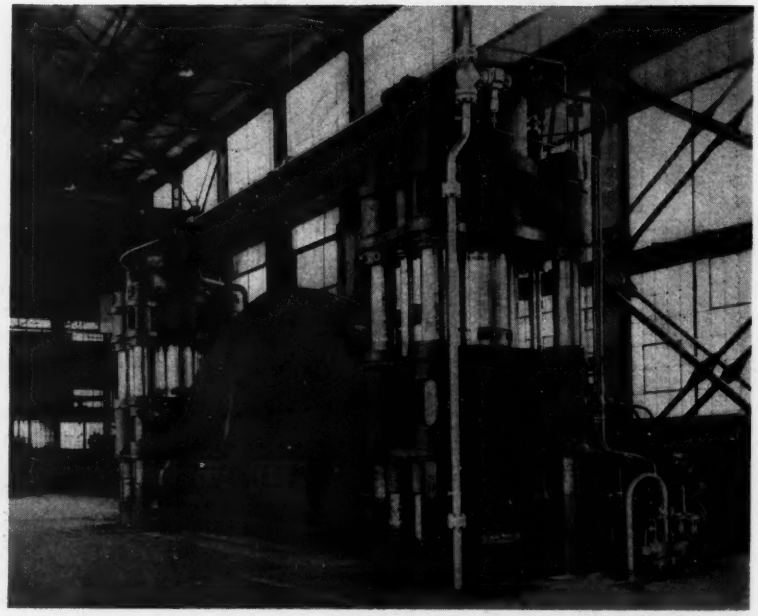
According to H. P. Sparks, Sales Manager, Meter Division, Westinghouse has introduced an economy program that may be of benefit to many industrial plants. The economy program is based on supplying Industry with economical electrical instruments with which they can analyze electrical and mechanical conditions in their plant; a low cost socket to be installed either in the conduit or adjacent machinery or control equipment. This low cost socket can then be jumpered out and used only when the instruments are to be put in service for testing.

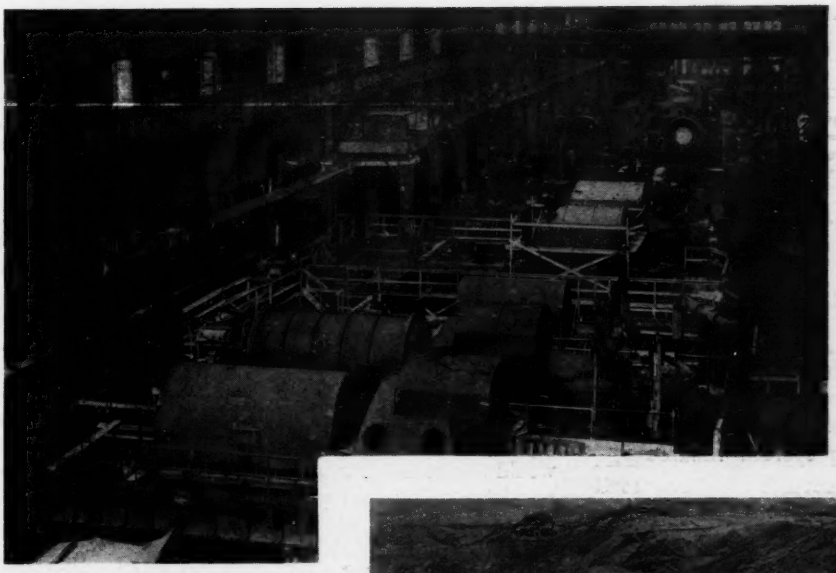
By means of the socket scheme; first, the instrument will serve many locations so that ammeters, voltmeters, wattmeters and graphic instruments can be applied on a moment's notice; second, the person who applies the instrument needs to know very little about the connections of the instrument itself thereby the fear of connecting electrical instruments is removed; third, once sufficient data is secured as to whether the motor is operating with the proper load, or whether the motor is creating a bad condition, or perhaps there is a loss in the feeder connection to the motor, the trouble can be cleared.

Have you ever wished that you might come back, say, in a thousand years to see what the world might look like then—whether the dream cities of Norman Bel Geddes would have materialized, whether human beings had sprouted wings or maybe if only to see whether the Republicans ever got in again? Well, if you have, and, of course you have, all we can say is that you never will. Your dreams will have to suffice in that respect. However, if we will not be able to see what the world looks like in a thousand years, we can do something to let the people a thousand years from now know what the world looks like today and so this month the Westinghouse Company is going to deposit a "Time Capsule" in the grounds of the New York World's Fair with the expectation that it will be recovered by archaeologists 5000 years from now! This capsule, shown at the left is a copper alloy cylinder about 7 ft. long and 8 in. in diameter lined with a Pyrex glass envelope embedded in waterproof material, evacuated and filled with nitrogen gas. Within this glass envelope will be placed a number of items representing a "cross section of our time"—selected products from our laboratories, books reproduced in microfilm, scientific formulae, etc. The capsule will be sunk 50 ft. beneath the Westinghouse World's Fair Building where it is hoped the archaeologists of 6939 A. D. may find it. At the left two Westinghouse engineers are shown inspecting the "Cupaloy" cylinder and its 6 ft. inner shell of Pyrex glass.

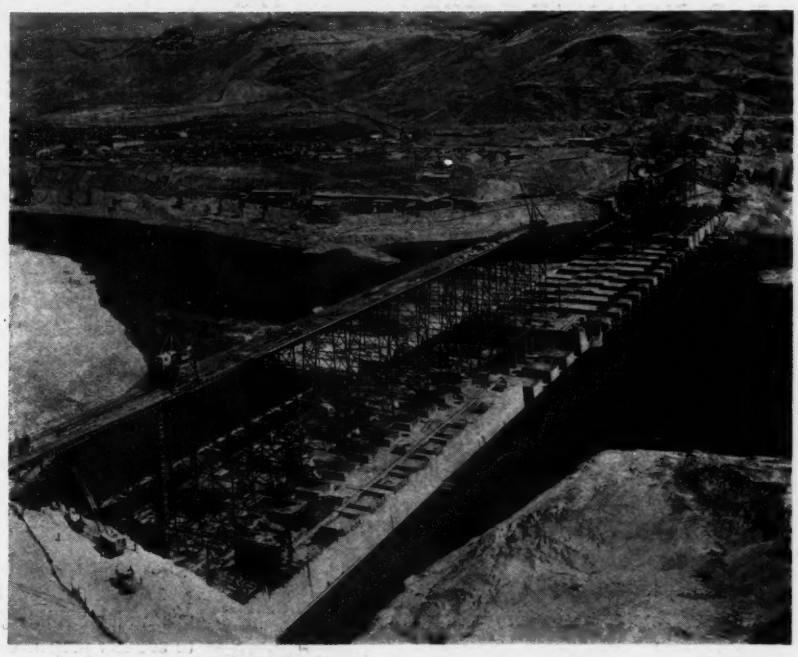
PICTURES of Engineering

Did you ever see a sheet of boiler plate 6 in. thick? And if you have, did you ever think of bending it? Whether you have or not doesn't matter, but here, at the right is a press that is capable of bending such plate, cold! It has recently been installed in the shops of the Hedges-Walsh-Weidner Division of Combustion Engineering Co., Inc., at Chattanooga, Tenn., and is the largest and most powerful press ever constructed for bending boiler plate. The press has a clearance between posts of 40 ft., 6 in. and consists of two, 3000 ton four post hydraulic presses connected by two built up beams. From the floor to the top of the cylinders measures 27 ft. and below the floor the equipment extends 22 ft. It is operated by water pressure of 1500 or 3000 lb. per sq. in. Some press, hey what!



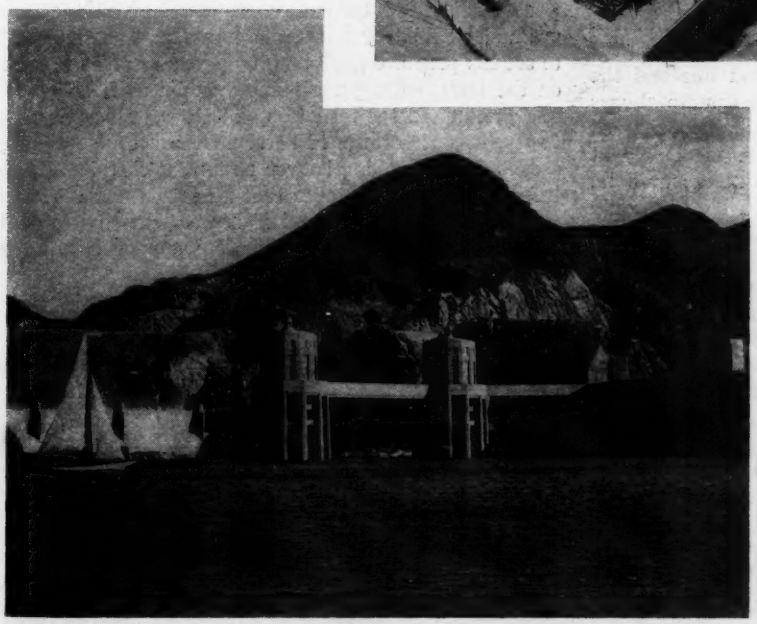


Here is another set of "quints"—five steam turbine generator sets being erected for test in the Schenectady Works of the General Electric Co. These five units have a total capacity of 140,000 kw. About ten months are required to build each of these machines, after which some four additional months are spent in testing them before they are disassembled and shipped to the customers. The "test" it will be obvious is quite as important a procedure as the manufacture itself.



Progress on Grand Coulee Dam continues. This, highest, longest and widest of the 3 concrete placing trestles to be buried in the concrete dam has yet to be completed, and the biggest single job of concrete placing of all time is started—the adding of 6 million yards to the 4½ million already in place in the base. (Photo, Bureau of Reclamation.)

Interest



Sportsmen note. One sailboat doesn't make a regatta, but there's room for lots more on Lake Mead, the great reservoir 115 miles long and over two thirds full which has formed behind Boulder Dam on the Colorado River. This view shows the Arizona spillway and intake towers. Since its completion by the Bureau of Reclamation in 1935 six generators have been installed in the power house and the highest voltage transmission lines in the world now carry power 270 miles to the Pacific Coast. The creation of Lake Mead as a result of the placing of the dam has opened up a new recreation center.

Some Heating System Faults and Remedies

Piping connections incorrectly made, valve failures, sediment accumulation and control adjustments are prevailing causes of heating system failures

By WILLIAM T. ESTTICK

HEATING difficulty was experienced in a school building consisting of a main building of six class rooms and a basement which contained the boiler room, lavatories, storage room, etc., and an addition which consisted of six classrooms, two on the first floor, two on the second floor and two in the basement. The ceiling height was 9 ft. in the main building, and 12 ft. in the addition, a ramp was laid between the two basements to allow for the difference in the floor level. This building was heated by a low pressure steam heating system, using side wall radiators, the radiators in the basement classrooms were consequently lower than the level of the boilers and lift fittings were installed in the returns, a vacuum pump was used to return the condensate to the boilers. At the time the addition was built No. 2 boiler was installed to take care of the additional load. The boilers were oil fired with a thermostat control in the main building and a time switch in the boiler room for starting up at a pre-determined time in the morning. Figure 1 shows the condition that prevailed in the boiler room. During operation the compound gages, one on the main steam line and the other on the receiver tank of the vacuum pump always read the same, if there was pressure both registered alike, and vice versa. The radiators in the basement classrooms would not begin to heat until about 5 lb. pressure was raised and sometimes even then it would be quite a while before they would start heating, and when they did begin the boilers would fill up with water, so that it was necessary to open the drain cock and allow the water to run into the floor drain through the hose kept there for that purpose, and the caretaker was kept constantly on the watch for such a condition. If it got away from him, there was considerable water hammer in the heaters of the boiler, particularly No. 1 and at times in the steam main. At other times when the pressure was up the boiler room would be flooded if the safety valves opened. As shown in the sketch, boiler No. 2 was set in such a manner that the normal water level was 8 in. higher than the normal water level of No. 1 boiler and at some time the water column had been disconnected from No. 1 boiler and reconnected as shown. After the radiators had finally become heated and the lines drained, the pump would stop, then operate intermittently but the same radiators would gradually cool off and after a while the cycle would repeat itself. Meanwhile the automatic feedwater regulator would feed water into the boiler to maintain the water level which would begin to go down as the radiators were cooling. Inquiring as to how long these conditions had existed, the reply was "about 10 yr., starting when the new addition was put in." In reply to the question as to why nothing had been done about it, the answer was "Everybody has had a shot at it but no one seems to know what is wrong."

In looking over the situation, I wondered why the 3/8 in. line was connected between the main steam line and the receiver tank, for if the check valve was holding it was of no use as a bleeder, and not having a trap it could act as a by-pass if the check valve was defective. I asked if I might try an experiment. The reply was "Sure, you can't make it any worse than the rest," so inasmuch as the boilers were down, I disconnected the union and started the pump and discovered that the check was leaking badly. So I shut the pump down, disconnected some of the 3/8 in. piping and plugged both open ends of the line. Then we proceeded to start the system up, the water began to come back immediately, and for over 3/4 of an hour we were draining water out of the system, and as we gradually raised pressure, the caretaker was surprised to see his pressure gage reading pressure and the gage on the tank reading a varying vacuum as it operated. We checked all the radiators and all were heating perfectly, except a large radiator in the corridor on the second floor. Looking it over I found it closed and was informed by the caretaker that a heating engineer had ordered it closed because "if it was opened it would unbalance the system." However, we opened it and it

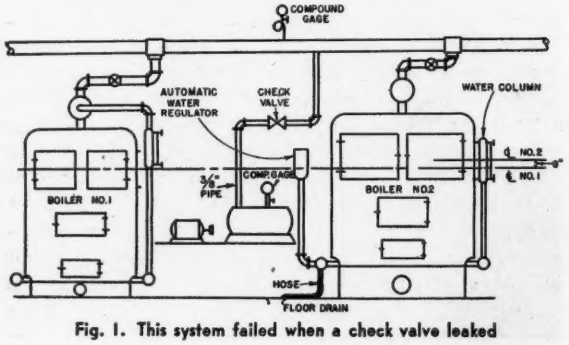


Fig. 1. This system failed when a check valve leaked

operated perfectly. All this happened during the Christmas recess, and as it was impossible to do much of anything about the other condition, as some heat was necessary, permanent changes and repairs were put off until the following summer. However, from then on until the end of the heating season in the spring, the saving of oil amounted to 30 per cent of the entire year's fuel bill, and netted almost enough to pay for the changes that were made, such as levelling the boilers, resetting the oil burner, resetting the water column on No. 1 boiler, cleaning out all lift-fittings, checking radiator traps, packing valve stems, etc. A re-check showed this system operating at a maximum of 2 lb. gage conditions, much improved in the basement classrooms and a normal operating procedure which relieved the caretaker for other duties during the day as well as creating a satisfied group of teachers and pupils and, best of all, paying a handsome dividend.

Incorrect Connections to Expansion Tanks

Another case was in a smaller building used as an automobile shop and classroom connected with a trade school. This building was heated by a hot water system and using about 60 t. of nut coal yearly. Figure 2 shows the condition found there. The janitor remarked that he was "forever checking the expansion tanks to keep water in them." The system was sluggish in operation with poor circulation, and the reason was obvious. The expansion tanks were disconnected, points A and B, also C and D respectively were connected together, the expansion tanks were connected to the return main, and after the heating season was over, another feeder was run from the boiler so that each section of radiators had its own supply direct from the boiler. The fuel consumption was cut to 30 tons per season, thus saving one-half of the former fuel cost and a more uniform and comfortable condition existed in the classroom. An interesting incident connected with this job was that the outfit that originally installed the system put in a bid of $600.00 for the overhauling of their own work.

Thermostat Needed Setting

Still another case was in a building having a lodge hall as well as a lot of other rooms. It was heated by a low pressure heating system using oil fuel, and employed a vacuum pump for returning the condensate. A blower system with an outside air intake, the fan being automatically controlled by an aquastat located on the return leg of the heater coil was used to heat the lodge room. The remainder of the building was heated by direct radiation, a thermostat located in the section of the building heated by direct radiation controlled the system. Heating conditions in the lodge room were far from satisfactory, cold air often came out of the grill fronted ducts much to the discomfort of those present. A year's bill disclosed something like $164.00 for service calls, charged against cleaning and checking traps, etc. A checking of the setting on the aquastat showed that it was set for a cutting out temperature of 120 deg. F. and with outside air at winter temperature it was much too low. This

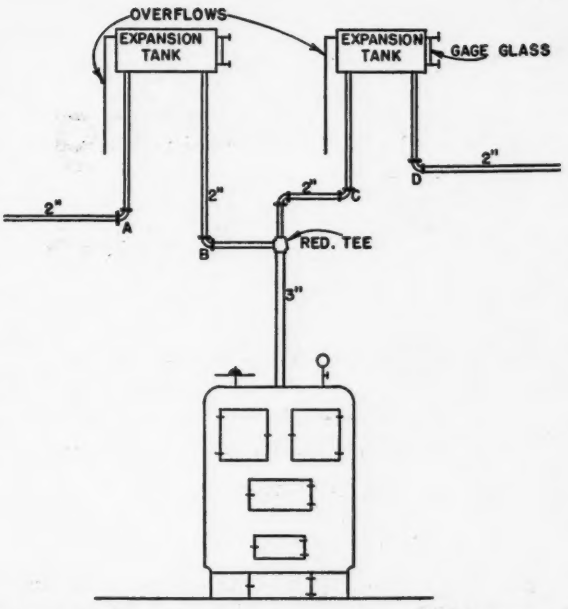


Fig. 2. Expansion tanks connected in supply mains caused failure

was adjusted and a thermostat installed in the lodge room in order to maintain the temperature desired. There was also a little difficulty with the water going back after the pump stopped. Upon examining the check valve in the return main, it was found to be leaking. However, a Hartford loop connection was installed on the return main and a new check valve also put in. The system operates satisfactorily and service calls have practically ceased.

Vacuum Valves Needed

A garage was heated by a low pressure steam boiler. This was a gravity return system, the boiler being located in the basement. They were using 30 t. of pea coal per season, and the owner thought it was too much. The system was well installed and the boiler plenty large enough to handle the radiation without forcing. However, all the radiators in the garage proper, the stock room and the office were equipped with plain air valves which required pressure to keep steam in the coils at all times. An expenditure of about $18.00 for vacuum valves in place of the plain air vent valves closed the system and it functioned perfectly. In mild weather it operated as a vapor system and was very satisfactory from every standpoint. The coal consumption is now about 15 t. per year, thus cutting the fuel bill in half.

Cleaning Helps

Another interesting case was in a school classroom. The janitor had to take a pan and a pail at intervals and take out the air valve to drain the water down to that level in order to get some heat in the coil. This was a long coil type radiator that ran on two sides of the room and the only source of heat. This was also a low pressure steam system having a gravity return with check valves in the individual return lines from the coil to the return mains. When

questioned as to what had been done, the attendant replied: "Oh, they have been here several times and changed the air valve." I opened the check valve and found it stuck tight with residue and dirt. After cleaning it thoroughly and easing it, for it was a swing check valve, the coil operated normally.

There were also two boilers in the building located in the basement side by side, and the janitor informed me that the water levels varied at times. I asked him if he had ever received instructions to blow down the water column occasionally, and he said: "No," so we blew both columns and after removing a lot of mud and dirty water, the water levels returned to normal and the janitor's mind was at ease.

Too Much Friction

In another instance, trouble was experienced in a school building when starting up in the mornings. The water would gradually recede out of the boiler and go out of sight in the gage glass. The janitor would admit a small amount of water at this point, keeping it low in the glass, for as the system warmed up the water began to come back and the level would rise so that it was necessary to draw off enough to maintain a normal condition. Afterward it would operate fairly uniformly. This was a low pressure steam heating system with gravity return, the wet return main running all round the basement, following corners, recesses, etc., which accounted for the sluggish action in the return. Shortening the return main considerably by running it overhead, so as to eliminate most of the bends, and dropping it to the wet return at about 2.5 ft. from the boiler where it had a direct flow back remedied this condition. This change eliminated 19 elbows and about 35 ft. of connecting piping. No further trouble was experienced with the sluggish return of the condensate, and the coal consumption dropped from 60 t. per year to 45 t.

How some of these installations ever get by the inspectors is hard to understand, also the reason for such work in the first place. A great many of these systems, however, are poorly designed and poorly installed, then it is somebody's headache to try to do something with them. Certainly boiler inspections should extend to take in unsafe conditions in piping or anything else that might react unfavorably as far as the safety of the boilers is concerned, particularly in schools and public buildings.

Smoking of house chimneys is being looked after by fire and police departments in Cincinnati, members of fire and police forces watching for offenders and calling to leave a copy of the booklet Which End prepared by Appalachian Coals, Inc., which gives instructions on starting a fire and firing by the alternate method. The plan, which has been inaugurated by Harry J. Wernke, director of safety, is fully approved by T. A. Day, Asst. Secy. of Appalachian Coals, Inc., as a means of educating householders in firing bituminous coals for economy, also by Gordon D. Rowe, chief smoke inspector who believes that it will assist materially in reducing smoke made in the city.

Nickel Alloys Expand Their Uses

DURING the current year, continued expansion and diversification of the use of alloys containing nickel has taken place. An increasingly large number of parts of machinery and equipment of all types is now being fabricated from a variety of alloys of which nickel is an influential constituent.

Recent trends include increasing consumption of stainless steels, expanding use of nickel molybdenum steels for highly stressed parts, and of nickel cast irons for pressure components and parts subject to heat, abrasion, wear and corrosion.

Expansion in the use of nickel bearing stainless steels of the 18 per cent chromium, 8 per cent nickel type has been noteworthy particularly in view of the low level of steel operations. Substantial progress was also made in extending the applications of low-alloy high-tensile corrosion resistant steels of the nickel copper type.

Considerable interest has been shown in ferro-nickel alloys, the wide range of properties obtainable by varying the nickel/iron ratio being utilized in a number of interesting applications although the bulk of the ferro-nickel alloys produced are still of the Invar type (36 per cent nickel and 64 per cent steel with 0.2 per cent carbon content) and are used largely in thermostatic bi-metals. Another special high nickel alloy, a combination of nickel, cobalt, aluminum and iron, has worked out surprisingly well for permanent magnets, developing higher coercive force than other magnetic materials available, and being moderate in cost. Because of their special properties, the use of magnets of this type permits of unusually compact design, and many devices formerly manufactured with wire wound magnets are now being built of permanent magnets of this type.

Pronounced advances have been recorded in the field of clad metals. Inconel-clad steel has become an important factor. A recently introduced companion to nickel-clad steel, it has been found useful where the relatively low cost of steel construction is desired with the corrosion resistance and other properties of Inconel. Perfection of a method for cladding rolls of steel, iron, bronze, aluminum and other materials with nickel, Monel and Inconel has lead during the past year to the solution of many roll problems in the pulp, paper, textile and associated industries.

Since alloys containing nickel are used primarily where the conventional metals are inadequate—where greater strength and toughness or greater resistance to heat, corrosion, wear or abrasion are desired—progress in 1938 inevitably reflects the development of trends previously established rather than a series of spectacular innovations. The steadily expanding use of alloys containing nickel is based upon the firm foundation of economics. The alloys must be more economical, ultimately if not immediately, than the simple metals they replace, and time is required to establish this position.

Hydro Developments on the Wisconsin River

New Tomahawk Plant, recently completed, and the Lower Grandfather Falls plant, now under construction, will add 19,840 kw. of hydro capacity to the Wisconsin Public Service Corp. system and virtually complete the development of the Wisconsin River

DUE TO THE NATURE of the country, the Wisconsin River has always been a source of good power, developed superficially by the early paper mills, and more intensively later by the utilities. Natural regulation, provided by numerous small lakes and swampy areas at its headwaters, has been improved by storage dam controlled by the Wisconsin Valley Improvement Co. until the stream flow is dependable even after periods of prolonged drought. The minimum regulated flow has been built up to about 1200 c.f.s. from an unregulated minimum flow of about 400 c.f.s.

From Prairie du Chien at the junction with the Mississippi to the headwaters the available sites have been utilized. These are all comparatively low head plants so that Grandfather Falls, one of the two recent developments of the Wisconsin Public Service Corp., is particularly interesting. By minor changes in the dam and the construction of a short canal, rapids for about a mile downstream are utilized and the head increased from 32 to 94 ft.

The other development, which was completed last spring, is the Tomahawk Plant. Both of these sites, formerly owned by paper mills, the first by the Grandfather Falls Co. and the second by the Tomahawk Pulp & Power Co., were acquired by the power company about four years ago. They both lie between Tomahawk and Merrill, Wisconsin, and are separated by the Tomahawk Kraft Paper Co. hydro plant at Grandmother Falls. These three plants utilize the complete fall of the river from Grandfather Falls up to the present Jersey Plant of the power company above Tomahawk.

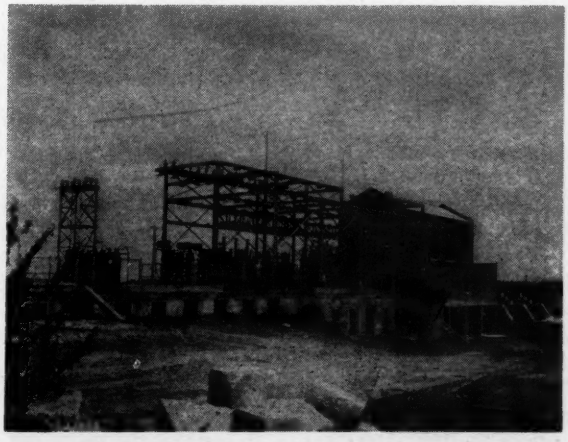


Fig. 1. Downstream view of the New Tomahawk plant and substation. Two 1300 kw. units operating under a head of 16 ft. are installed. The substation foundation is part of an old paper mill building

At the Tomahawk Plant, shown by Fig. 1, are installed two 2070 hp., 120 r.p.m. S. Morgan Smith wheels operating under a normal head of 16.0 ft. and driving Allis-Chalmers 1300 kw., 3 ph., 60 cycle, 2400 v. generators and 30 kw. direct connected exciters. It is at present operated by Westinghouse supervisory control from the old Grandfather station which will later be placed on standby or used intermittently during periods of high water. At that time the control will be shifted to the new Grandfather Plant. The Westinghouse switchboard consists of the supervisory, 2 generator and five feeder panels. The supervisory control operates at 48 v. from an Exide battery, kept charged by a 2 kw. Diverter pole charger set. In the adjacent switchyard are two banks of G.E. transformers moved from another plant; one bank rated at 1000 kv-a., 2300/4400 v., the other at 200 kv-a., 2300/7260-12570 v.

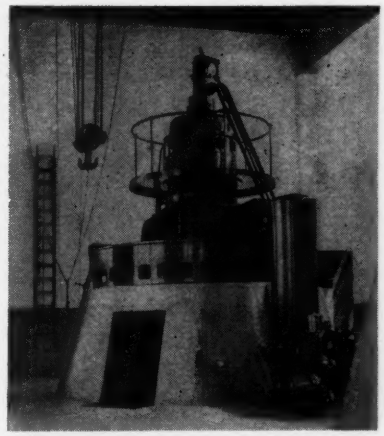


Fig. 2. Interior view of the Tomahawk plant showing one of the two 1300 kw. units now operated by supervisory control from the Upper Grandfather Falls plant farther down the river. When the Lower Grandfather Falls plant, shown by Fig. 3, is completed the control will be shifted there and the Upper plant placed on standby or operated when, in the spring there is surplus water

Both units have Woodward type HR, 21,500 ft. lb. governors. Other auxiliary equipment consists of: a 25 t. Whiting crane; Gurley head and tail water recorders; 2 Goulds bearing-water pumps driven by a G.E. ½ hp. motor with Mercoid pressure control; a Quincy air compressor driven by a ¾ hp. motor for the air brakes; and a Roots-Connersville blower driven by a Westinghouse 7½ hp. motor for providing air to keep the gates free of ice.

The dam, of the concrete and earth fill type, is 21 ft. high and about 600 ft. long. It has a 235 ft. Tainter gate section with five 31 and four 20 ft. gates,

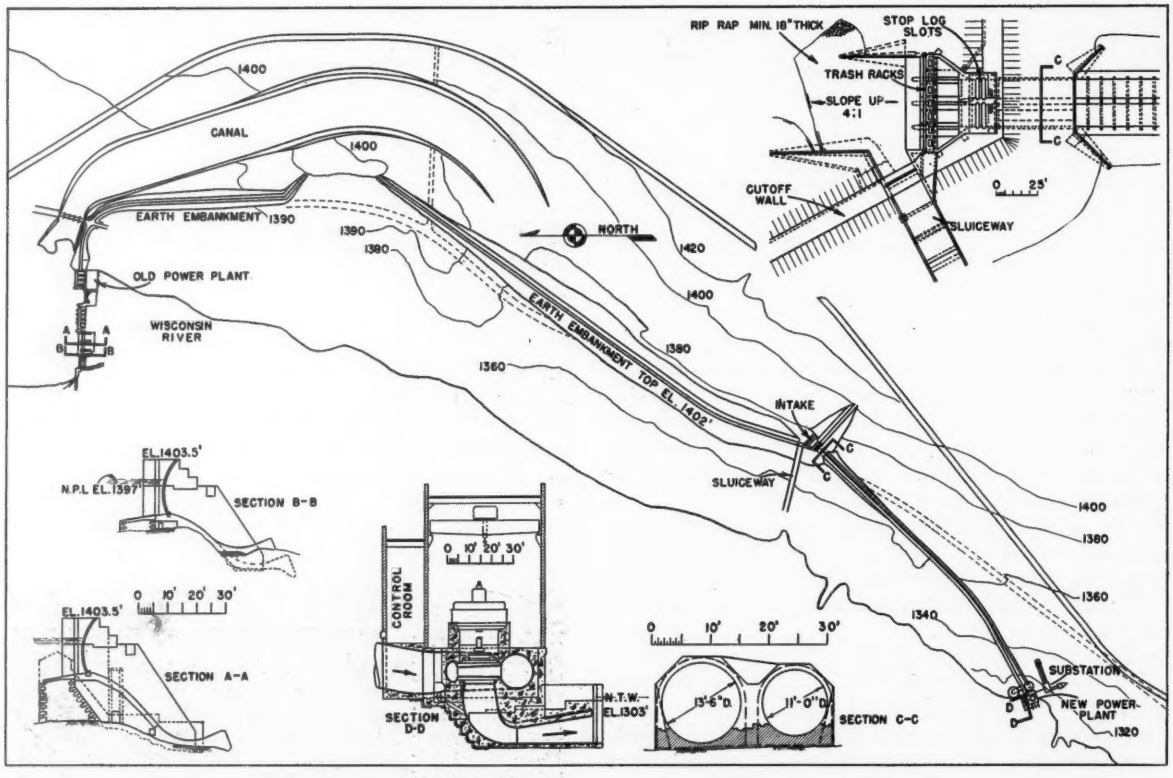


Fig. 3. General plan of the new Grandfather Falls Development. The present power plant house built in 1902 will be retired to standby and intermittent service during high river flow. The old dam will be rebuilt with increased flood capacity. Water will be carried by canal and wood pipes to a new plant below the rapids so as to increase the head to 94 ft. Two new units, one 11,000 and the other 6250 kw., will be installed

raised and lowered by two D. J. Murray electrically operated hoists mounted on manually propelled cabs.

A few miles down the river is the Grandfather Falls development shown by Fig. 3. The present plant operating under a head of about 32 ft., was built about 1902, but was modernized when the company took it over a few years ago, and now has three horizontal shaft units totaling 3000 kw. The present dam will be rebuilt to increase the head water level about 2 ft. One of the present units will be abandoned, as water for its operation will not be available when the new plant is put into commission. The remaining two will be kept for standby purposes, and to use the surplus spring run-off.

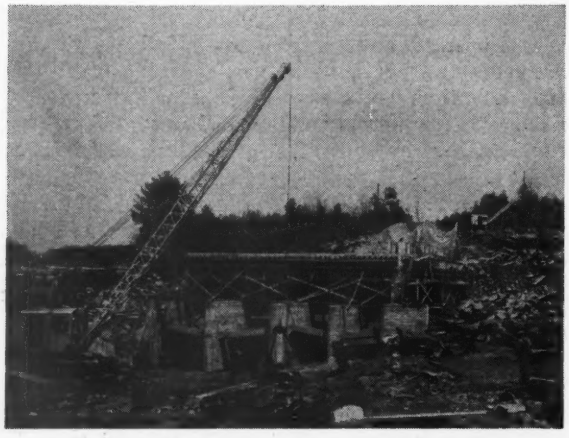


Fig. 4. Construction view of the new Grandfather Falls plant taken late in May. The Upper Falls plant is upstream just around the bend in the river

Water will be diverted into a canal as shown, flow into a small pond formed by an earth embankment, through the intake and two woodstave pipe lines to the new power plant at the foot of the rapids. The total head developed will be 94 ft. The larger of these two pipe lines, 13 ft. 6 in. in diameter, will supply a 11,000 kw. unit, the smaller, 11 ft. in diameter, a 6250 kw. unit. Equipment and arrangement are similar to the Tomahawk unit with S. Morgan Smith wheels, Allis-Chalmers generators and Woodward governors. The large pipe line will have a surge tank 51 ft. in diameter and the small pipe line will be connected to a surge tank 39 ft. in diameter.

Engineering work on both plants was done by The Public Utility Engineering & Service Corp., and the construction has been supervised by the Wisconsin Public Service Corporation. The C. R. Meyer and Sons Co. of Oshkosh has been general contractor on both jobs. The construction cost on the Tomahawk plant was approximately $565,000 and the estimated cost of the Grandfather Falls development, including substations and transmission lines to connect with the company's system at Wasau about $1,700,000.

Boiler Test Data Recorded With Still Cameras

E. B. EVERETT
The Detroit Edison Co.
Research Department

DURING an important boiler test it was necessary to measure the movement of certain boiler tubes with respect to the steam drums, and the temperatures of these parts during the entire period that the boiler was being filled, fired and brought up to steaming, preparatory to being put on the line.

The tube movements were indicated by a group of 12 dial gages that were located in a small space between the back of the boiler and a coal hopper. Figure 1 shows the gages and also a synchronous clock which was used as a time reference for all gage readings.

Temperatures of the boiler tubes and drums were obtained with 22 thermocouples which were peened into the parts to be measured. Eight of the thermocouples were connected directly to eight indicating potentiometers arranged in one group. The other 14 thermocouples were brought to a second group of instruments consisting of three selector switches and five indicating potentiometers. Two thermocouples of this group were connected directly to potentiometers, and the other 12, which were less important, were connected to the three selector switches which in turn were connected to the other three potentiometers. Figures 2 and 3 show these two groups of instruments each with a synchronous clock to maintain an accurate time reference for the data obtained.

Fig. 1. Dial gage assembly used to indicate movement of boiler tubes with respect to steam drum

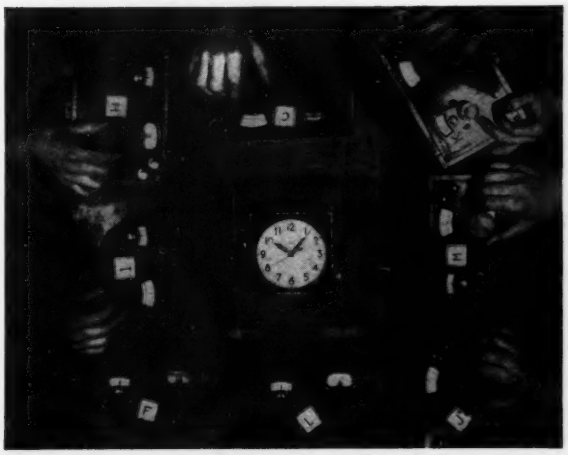


Fig. 2. Group of potentiometers used to indicate temperatures

It was important that the dial gages, potentiometers, and synchronous clocks should be accurately and rapidly read and the readings recorded. Lack of space where the dial gages were located prevented the use of enough observers to obtain simultaneous readings, and the rapid changes of the gage indications prevented successive readings by one or two observers, so it was decided that the readings would have to be recorded by some photographic method.

Motion picture cameras were tried as a possible solution of this problem but it was not possible, with the equipment available, to cover the area occupied by the dial gages and have the images on the film sharp enough to be easily read.

It was demonstrated that, with a suitable still camera, the images on the film could easily be read with a ten power magnifying glass, and when the camera was fitted with a film pack, an exposure could be made every ten seconds. Although it was not known at the outset how rapidly the instrument read-

Fig. 3. A second group of potentiometers used to indicate temperatures

ings would change, one exposure every ten seconds was considered sufficiently often for this test.

In order that a complete photographic record of all data might be obtained, three view cameras with 4-in. by 5-in. film pack adapters were used to photograph the three groups of instruments. Each camera had a spare film pack holder, so a loaded holder was available at all times. The loaded holders were handed to the operator without the safety slides, the safety covers of the film packs themselves being relied upon to prevent exposure, thereby saving an extra operation by the photographer.

Photoflood lamps were so arranged as to minimize image reflections from the cover glasses of the instruments and the light was of sufficient intensity to give good exposures at one-fifth of a second when the lenses were stepped down enough to have the entire field in sharp focus.

The potentiometers were kept balanced at all times so that any temperature changes could be detected. The frequency at which exposures were made was governed by the changes indicated by the instruments and varied from one every 10 sec. to one every 5 min.

During the test, which lasted for 10 hr., 147 film packs, or 1764 exposures, were used to photograph the instrument indications. This photographic record represented a total of 17,596 individual readings, including time.

Super plenachrome film was used for the test and the exposed negatives which were developed in Eastman D-11 were, with few exceptions, very clear. The instrument readings were easily obtained directly from the negatives with the aid of microscopes and by projection. Figures 1, 2, and 3 were taken from typical negatives but they have lost some of their sharpness in reproduction.

The 17,596 individual readings were used to plot running curves of mechanical movement and temperature versus time. The correlation of the data obtained is not within the scope of this article and will not be discussed here, but a permanent and accurate record of the data is now available for future reference.

Boiler Accident Records

By C. C. CUSTER

BOILER ACCIDENT records are of considerable interest to engineers as they indicate *how* and *why* boilers fail, *what* to avoid, and *what* to look out for. Different types of boilers fail in different ways; different designs have different inherent weaknesses.

A *boiler accident* may be defined as not necessarily being an explosion but any cause or happening that lies outside of standard methods of operation, and which injures or shortens the life of the boiler.

Whenever we find the same thing, according to records, happening to certain types of boilers again and again, we may regard it as a typical accident or one that recurs so often that every engineer should be posted on its cause and prevention.

A study of boiler accidents also demonstrates the fact that the failure of a boiler is often a case of how men fail. Some men who have possibly had charge of boilers for many years and never had a serious accident, sometimes in sheer confidence allow themselves to fall into unsafe practices and fail to observe all the safeguards that are supposed to be necessary in standard methods of operation.

A study of boiler accidents discloses the fact that the greatest hazard is *overpressure*. Next to this comes the hazard of *low water*. Next in order comes a number of accidents which seem to indicate that the equipment was not at fault but the personal equation broke down; the engineer had failed in some way.

There are engineers and engineers. I believe the best engineer is the one who not only knows how to run his plant but also has a well-defined vision of all the possible hazards involved; who is well versed in safe practices; who anticipates and prevents dangerous conditions from cropping out; who always keeps his safety devices in operation; who always packs his boiler feed pump before it breaks down in service; who never puts off his regular cleaning time for the boilers that are in service; such an engineer keeps his plant running from day to day without accidents and we often fail to appreciate him at his full worth.

It is not enough, however, to be an experienced engineer, but one should be able to capitalize the experience of others, which can be done by making a study of standard practices. Obviously an engineer should not only be able and organized to take care of emergency repairs but should also be well versed in standard practice routine which is effective in keeping down accidents to a minimum. There should be a definite program and routine of operation and each employee should be trained to realize the importance and responsibility of his definite duties. Engineers are not born; they are trained and much depends on the proper training of the employees in their respective duties. Their work should be constantly checked up to see that it is up to a high standard of efficiency.

R. S. Redmon, for many years with Stone & Webster, is now plant engineer of Kellogg's at Battle Creek, Mich.

* * *

Pickle works and the 57 Varieties take a lot of steam . . . H. J. Heinz Co. just completed a new plant with three 45,000 lb. per hr., 200 lb. pulverized coal fired boilers at Fremont, O. . . . Chief engineer J. W. Snyder says this will be duplicated by a new section ready in 1939.

* * *

According to R. R. Vennum, asst. ch. engr. of the Continental-Diamond Fibre Co., Newark, Del., the new 600 lb. boiler and auxiliaries fit into a space 29 by 28 ft. and 26 ft. high . . . This is 18.04 sq. ft. or 469.16 cu. ft. per thousand pounds of boiler capacity.

* * *

J. H. Ames is city manager of Ames, Iowa . . . He is installing two 40,000 lb. per hr., 450 lb. boilers with all the trimmings. Last month the Sutherland Paper Co. at Kalamazoo, Mich., started up a new Wickes boiler fired by a Detroit Stoker. Earl Dunton, C. E., says it's a 607 hp., designed for 300 per cent continuous rating—waterwalls, superheater and air heater.

* * *

J. Byron Sims, superintendent of the Board of Public Works, Grand Haven, Mich., used to be assistant to Joe Cannon, supt. of power of the Carbon & Carbide plant at Charleston, W. Va. . . . He now has a Diesel plant, with the old steam plant a standby . . . Appreciable fuel savings have been made by installing a large oil storage tank and keeping a weather eye on the spot market.

* * *

To get the necessary secondary air at high ratings without admitting cold air through the fire doors, John Zogrlmann, chief engineer of the Wolf River Paper Co., Shawano, Wis., installed a motor driven blower taking hot air from top of the air-cooled walls and discharging through a bifurcated duct to an air jet on each side of, and just below, the single burner of the Johnson boiler.

* * *

Ralph Roe, of Burns & Roe, N. Y., with South Amboy and Bremo Bluff to his credit is consulting engineer for the new Ottawa St. Station at Lansing, Mich. . . . . C. R. Erickson, Mech. Eng., of the Lansing Board of W. & E. L. Comm. is not only a good engineer but spent his spare time studying law and passed the bar examination a year or so ago . . . Sketches of the new station show a unique exterior color scheme, a black onyx base grading up through red, yellow and gray, to typify the combustion process from coal to smoke.

O. E. Eckert, general manager, gives credit for this unique touch to the architects.

'Round About

with the Engineering Editor

THROUGH the grapevine comes word that J. C. Hobbs, Supt. of Power of Diamond Alkali, Painesville, O., is thataway about a 2200 lb. plant which is progressing nicely. . . . With Twin Branch slowed up, the distinction of the highest pressure in America will be shifted from the Philip Carey Co. to another industrial. . . . High pressures and temperatures have placed alloy steels permanently in the boiler picture and Donald Jarman, a metallurgist of wide industrial experience, has joined the Wickes Boiler organization.

In August the Tri-County Electric Coop. started up a new Diesel plant, with two 500 hp. Worthington engines, which with two hydro plants of 390 kv-a. capacity will supply about 500 mi. of rural lines in the vicinity of Eaton Rapids, Mich. . . . Frank Wilson has also been hustling along a 3000 hp. REA Diesel station for the Thumb Electric Coop. at Ubly, Mich. . . The Southern Michigan Eng. Co. of Lansing engineered both. . . . Don Decker, late of the Goshen, Ind., municipal plant, is the chief engineer at Ubly in the Thumb of Michigan just south of Bad Axe. . . . An intriguing name that goes back into history and concerns an Indian who wandering through the woods found on axe partially buried in a tree trunk. . . . It was broken, hence to him a "Bad Axe". . . . The axe has been lost but the name lingers on.

John Bates, chief engineer of the Wisconsin Power Coop. new 3000 hp. Diesel station at Chippewa Falls., Wis., comes direct from the Busch-Sulzer shops in St. Louis, Mo. . . . Carl Johnson erected the engines. . . . R. B. Wyant, another Busch-Sulzer erector recently completed a large REA plant at Winchester, Ill., engineered by H. E. Caldwell of Jacksonville, Ill.

Algae growths in condensers have not bothered A. H. Petersen, superintendent of power, Kalamazoo V.P.P. Co., since he started using bleach solution periodically in the cooling water. . . . The chlorine in the solution does the job nicely. . . . The Great Lakes Steel at Detroit are installing two new Riley units arranged for firing coke breeze, blast furnace gas and coke oven gas . . . The coke on traveling grates will carry base load, blast furnace gas will be used as available and the balance of the fuel requirements made up by coke oven gas. . . . J. A. Claus is chief engineer.

Because of the dust, coal conveyor compartments offer a fire hazard. . . . After a fire has started conventional housings create a chimney effect and it is reported that at the Consumers P. Co's new Bryce E. Morrow station a low melting point zinc alloy will be tried. . . . The idea being that a fire will quickly melt the zinc housing and destroy the chimney effect. . . . Mark Hanna is an engineer for the state of Michigan, Building Dept., Room 202, State Office Bldg., Lansing. . . . Earl Norman, general superintendent and Ralph Emmons, plant superintendent, are looking forward to the completion of an addition to the Kalamazoo, Mich., municipal plant. . . . Steam conditions will be boosted to 400 lb., 700 deg. F. . . . A 2000 kw. Allis-Chalmers turbine, C. H. Wheeler condenser, Springfield boilers and Detroit stokers.

L. Skog of Sargent & Lundy spent the summer in Europe from his native Norway as far south and east as they could or would talk power. . . . At the T.A.P.P.I. program in Green Bay, Wis., early in September, heat and power had a prominent place with papers by Smith and Du Bois of Kimberly-Clark, Kolflat of Sargent & Lundy and Kuhner of Riley Stoker . . . Essential principles of the last two are incorporated in the Northern Paper Co. plant which is nearing completion. . . . Harry Gochnauer, chief engineer N. P. Co., is now preparing an article on the plant. . . . H. H. McMeen, the S & L engineer on the job, and W. C. Kowaleski, assistant to the chief engineer N. P. Co., are pushing things along with a view toward initial operation in November.

Wisconsin uses a large amount of Scandinavian pulp which is mixed with Canadian pulp to improve the quality of tissue and tramp steamers from the Scandinavian countries are no novelty to the natives of Green Bay. . . . Because of the large percentage of tissue produced, Wisconsin paper mills are not greatly worried about the new mills in the South and even the recent announcement of a huge four unit newsprint mill in Texas does not cause undue concern. . . . When Canadian mills took over the newsprint market some years ago, newspaper interests were strong enough to block a protective tariff on newsprint and New York mills were forced to step up to book paper or go out of business. . . . Without this organized opposition, tissue mills should get adequate tariff protection against Canadian competition if the South takes the newsprint business from Canada.

Richard H. Morris

Readers' Conference

These pages are open to readers for the presentation or discussion of any timely power plant topic. The Editors invite your participation.

Transformers in Industrial Plants

MANY INDUSTRIAL plants are served with 2300 v. three phase current. The bulk of the power requirements are met with 2300 v. induction and synchronous motors. There are, however, certain places where smaller motors require 220 or 440 v. current. Besides this 110 v. must be supplied for the lighting system. The fact that the main service is metered at the higher voltage usually means a 5 per cent discount on the bill which may mean a considerable saving in power costs. Buying current at the higher voltages does mean more investment for the plant in transformers.

In many plants, especially the older ones, a considerable saving can be made by rearranging and checking up on the transformers used about the plant. Due to changes in load and changes in production routine one transformer bank may be badly overloaded while another is operating very inefficiently because no load or only a small load is being used. It must be remembered that a transformer on the line take some current even when there is no load. This core loss remains practically constant from no load to full load. Looking at the accompanying table which gives efficiency and core loss for transformers ranging in size from 1½ to 50 kv-a., it will be seen that even a ten kilowatt transformer has a core loss of 61 watts. If the transformer were connected and not being used for the full 720 hours a month 43.9 kw-hr. would be registered on the meter. If the transformer were in use only 8 hr. a day or 48 hr. a week the total inactive hours would be 720 less 192 (4 × 48) or 528 hr. or with a core loss of 61 watts the kilowatt hours wasted would be 32.2. Depending upon the rate paid for current the loss in money would be appreciable. It is always good policy to get the proper sized transformer for the load it is to carry. Suppose that the 2300 v. service to this particular group of machines was to be cut off at the end of the working day. This amount of current could be saved. In many cases the same transformer bank used to supply three phase 220 v. current is tapped to supply 110 v. for lighting. When this is the case it would be impossible to cut off the bank at the end of the day. In many cases it would pay to operate a smaller transformer for lighting only so that the power bank could be cut off.

TABLE

KVA.	Core Loss in Watts
1½	20
3	28
5	37
7½	51
10	61
15	82
25	123
37½	155
50	195

Voltage 2400/4160Y—120/240 or 240-480 or 600 volts. Courtesy of the Pennsylvania Transformer Company.

Naturally the solution to any problem of distribution inside the plant must be worked out for each individual plant and what might be practical in one case would not necessarily be practical in another. In one large plant it was possible to cut out entirely 150 kv-a. in transformers by rearranging and cutting down the size of some banks. By cutting off 5-10 kv-a. and 250 kv-a. in transformer capacity the core loss was cut 512 watts an hour or 386.6 kw-hr. a month. This is assuming that the core loss was as indicated by the table which is for up-to-date transformers. Several of these transformers were of the older type and there is no doubt but that the core loss was considerably more than this. This is just one illustration of how a thorough study can be made to pay dividends. Also by operating the remaining transformers at higher loads better efficiency was obtained.

Sayreville, N. J. K. B. HUMPHREY.

Safety Pointers When Operating Extraction Turbines

FROM a safety standpoint, perhaps the most important devices in industrial extraction turbine layouts are the non-return valves between the turbine extraction chambers and their connecting steam distribution piping. These valves are provided to prevent a back flow of steam from the distribution system when the extraction mechanism is moved to its wide open position and the turbine is operating condensing. If the non-return valves do not close dangerous overspeeding may result, particularly when the machine comes off the line or when operating with reduced electrical loads. Under these conditions steam stored in the piping or supplied by make-up reducing valves will feed back into the extraction chamber and pass through the last stages of the turbine to the condenser. This steam is beyond control of the speed governor and even though the overspeed governor trips the throttle valve the turbine will continue to gain speed until the flow is shut off manually. Excessive overspeeding will seriously damage the unit and may cause a disastrous explosion.

Extraction line non-return valves arranged to close forcibly and preferably equipped with oil cylinders under control of the turbine overspeed governor are far superior to ordinary check valves for this service. No type of non-return valve is infallible, however, and the following operating and maintenance precautions should always be observed:

1. Test non-return valves frequently to be sure they are in good working condition. Testing is especially important after installing new packing or performing other maintenance.

2. When taking the turbine off the line ease off the steam load gradually, observing the non-return valve closely to be sure it closes.

3. Install pull chains on the balance weight lever of the non-return valves or provide other convenient and positive means of affording quick closure.

4. Provide a quick method of breaking condenser vacuum as it is often possible to control overspeeding by this means.

5. Keep extraction line stop valves in good condition so that in the event of an emergency they can be quickly closed.

Roanoke, Va. S. H. COLEMAN.

License Laws

BELIEVING, as does Mr. Fredrickson, whose article appeared in the May issue of POWER PLANT ENGINEERING, in the desirability of rigid license laws and enforcement, I feel constrained to add to what has has already been said on the subject.

Mr. Fredrickson cites examples of operating incompetence that are all too frequent in communities having no license code, but he doesn't stress the most important point, that of safety. When you've seen, as I have, the damage resulting from incompetent handling of a boiler, the necessity for regulation becomes apparent.

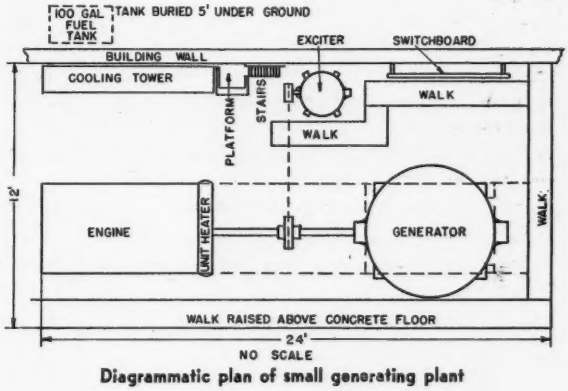
Primarily, a boiler inspection and license code is an instrument for the protection of the public safety, and it has been my experience, before several local municipal boards and the Steamboat Inspection Service, that a thorough understanding of the fundamentals of safe operation is the first requisite. Secondarily, but by no means unimportant, are questions involving the applicant's knowledge of such subjects as mathematics, physics and mechanics and his ability to apply such knowledge, in a practical manner, to problems in operation. To be sure, the questions are specific and to one not thoroughly conversant with the subject, they might also appear disconnected insofar as one section of the examination might deal with boilers, another with pumps, reciprocating engines and gear, turbines, etc. I have yet to see, however, a competent engineer rejected by a board or examiner.

On the other hand, there are, undoubtedly, incompetent licensed operators, a condition largely due, I believe, to the use of a standard set of written questions, that is, a single set of questions for any given grade of license, insufficient exercise of discretionary powers of the examining body in the oral examination, and, perhaps, politics. The remedy is to remove the political angle, provide a flexible written examination covering basic subjects, with an oral examination into detail, to remove the possibility of chiseling that occurs when a prospective applicant has access to examination questions, memorizing the answers, through some union or association or from some acquaintance who has successfully appeared for a license. When such a course is uniformly adopted, with state or even federal supervision, the standards of the profession will rise, the competent, conscientious engineer will not have to contend with competition offered by some truck driver or laborer who, through force of circumstances, is pressed into service as an operating engineer, resulting in a detrimental effect on conditions, the owner will profit through lowered operating and maintainance costs and removal of hazards of destructive incompetence.

Bremerton, Wash. ALTON W. LANE.

Power from Auto Engines

A SMALL manufacturer of my acquaintance was engaged in the manufacturing of store and restaurant fixtures, refrigerator display counters, coolers, refrigerators, floor and counter display show cases for fountain pens, pencils, razors and cutlery besides etching names and trade marks on glass, finally branched out in a small way into the house trailer business, in addition to his other activities. To run the machinery, there were a total of 85 hp. in motors installed, and power was purchased from a public service corporation. The bills for light and power averaged $150.00 per month.



Diagrammatic plan of small generating plant

This was quite an item when the business got down to a point where from 3 to 10 days per month was the limit of operation. The owner came to my place about 4 yr. ago and was telling about the situation and in a joking manner I made the remark, that "maybe it would be a good idea to buy up some used auto motors, equip them with governors and cut out the purchased power. Nothing more was said at that time but the idea took root.

About a year ago I happened to be in the city where he is located, so called on him and the first thing he said was, "Come here and see what we worked out from the idea you gave me."

He had bought a used automobile engine, thoroughly overhauled, and in first class condition, rated at 45 hp. in the belt, and generator built to run at 1200 r.p.m., 240 v., 1015 amp., 42 kv-a., 3 phase. The exciter was rated at 10 hp. (This machine was rebuilt and the only mark on it was stamped with a stencil.) The governor for the engine was made by a manufacturing company of

Minneapolis. The outfit takes up a floor space approximately 12 ft. by 24 ft. The generator is directly connected to the engine shaft by means of a coupling which also serves as a pulley to drive the exciter by means of a belt. The regular radiator for cooling the engine was dispensed with and a unit heater coupled up in its place. A tank of 150 gal. capacity was mounted on the wall at a higher level and a float valve for regulating the water level in the tank installed in a line from the city water main, so that now they have a supply of hot water for any purpose desired, besides the heat available from the heater, during the heating season. The heater is rated at 750 sq. ft. of radiation with fan running. Gasoline costing $0.12 per gal. is used for fuel and the average amount consumed is 20 gal. per day when operating at full capacity. The load has been divided and work so laid out that not over 45 hp. can be put on at one time. The engine was purchased at a price so low that when it gets in a condition where a thorough overhauling is needed, such as, new pistons and rings and reboring of cylinders, it will be cheaper to junk it and buy another one. To date they have worn out one engine and installed the second one. In addition to the fuel about 1 qt. of oil is used per 8-hr. day. He figures that he is about $1000 ahead on his power bills even if he operated on an average of 300 days of 8 hr. per year, which he does not. The basis of $2.40 fuel cost for 8 hr. was determined from actual tests conducted under regular operating conditions and from these he compiled the following:

Cost of purchased power, whether operating or not		$1800.00
Cost for fuel as now operating if running 300 days per yr. 300×$2.40	$720.00	
Allowed for oil, water, etc.	80.00	
Total		800.00
Yearly saving if operating steady		$1000.00

As there have been periods of 30 to 45 days duration that this unit has not run at all and other times when he alone has been in the plant for 13 hr. at one stretch and the total cost for that long day was $1.30 for fuel, the actual savings to the business was considerably more, as the expense stopped when the engine was shut down. In the heating months, a cast-iron steam boiler furnishes steam at 15 lb. pressure. Having a large storage capacity, all shavings and sawdust are stored when heat is not required and used for fuel when needed. Very little other fuel is needed as under the present system all hot water needed is furnished as described, where formerly it was taken from the heating boiler and that meant fuel of some kind the year round. A 1000 dollars may not look very big to some concerns, but to the little fellow who has his whole business practically under his hat and is everything from president down to a sweeper, that amount represents a worth-while saving.

Superior, Wisc. FRED S. RUTLEDGE.

New Blood

IN THE July issue of POWER PLANT ENGINEERING, the editorial, New Blood, reminds me of an incident that occurred in a western city several years ago.

One of the jack knife bridges over the river, running through the city, failed to come down one morning. Traffic piled up quickly. A hurried call to the power company brought a car with three young men to the bridge.

They piled out with books and blueprints in hand. A consultation took place with the bridge tender. Business of going over books and prints took place. Much talk followed about phases, induction, watts and amperes, and the traffic continued to pile up.

Then a car slowly pushed its way down the edge of the traffic and a short, stout, elderly man climbed out. The young men approached him and began pointing out certain things on the blueprints. Turning to his chauffeur, the old gentleman snapped. "Drive to the plant and get Mike, get him quick."

The car backed out and disappeared, returning in a few minutes, and an old overall clad chap climbed out. "Get that bridge down, Mike," the old gent said, waving his cigar at the offending bridge.

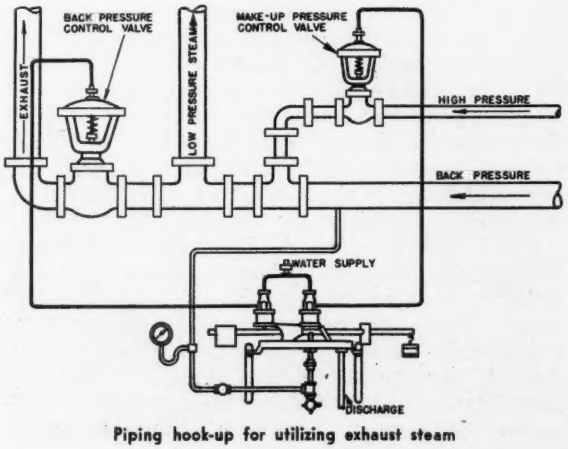
Mike climbed down under the bridge. After a few minutes he called out to try it. The bridge tender shoved in the switch and down came the bridge. Mike climbed out wiping his hands on a piece of waste. "What was wrong, Mike?" the boss asked. "Nothing much," Mike replied laconically, "just a fuse blowed." Casting a scornful eye at the discomfitted young men they climbed in their car and disappeared in the traffic.

Experience proves that there is no substitute for Experience.

Wilkes-Barre, Pa. THOMAS M. STREET.

Utilize Your Exhaust Steam

I NOTE with interest that I am sort of "taken for a ride" by my good friend James O. G. Gibbons in the March issue for stating that one can "see" much valuable exhaust steam going to waste if one will but go to the trouble of looking out of a car window while traveling through our cities on a railroad train.



Piping hook-up for utilizing exhaust steam

Lest readers may be led to believe that in my opinion wastefulness cannot sometimes be economical, a short article on that subject, which I wrote, was published in the July, 1937, issue of POWER PLANT ENGINEERING, page 439. I agree with Mr. Gibbons that it does not always pay, in dollars and cents, to save every ounce of exhaust steam. Saving has its limitations nearly everywhere. Thus if I should accidently drop my wallet containing some much needed money into the ocean, and it should sink to a depth of one mile, it probably could be recovered, but at terrific expense. The best way out of such a situation is to forget it, especially when it is my wallet. Should it be a Lusitaniaful of gold—that would be different.

And now that we agree on that point, herewith is a sketch of a piping hook-up for utilizing exhaust steam which I believe will interest many engineers. It is one of the simplest and best, from every standpoint, that I have seen.

This arrangement makes it possible to utilize 100 per cent of the exhaust provided such usage is at all possible. Should there be a surplus of exhaust steam at any time it is automatically switched by the regulator into the atmosphere. If on the other hand the amount of exhaust steam is insufficient for requirements, the sensitive control device automatically admits live steam make-up into the exhaust. Then, as soon as the required amount of extra heat is supplied the live steam is again automatically cut off.

In other words this arrangement guards the exhaust and saves live steam with the utmost precision—much more efficiently and economically than would be possible with the best of human supervision and hand control.

An important advantage is that this arrangement usually permits the utilization of much of the old piping and valves. That is, it is not necessary to install entirely new equipment throughout in attaining the highest degree of modernization.

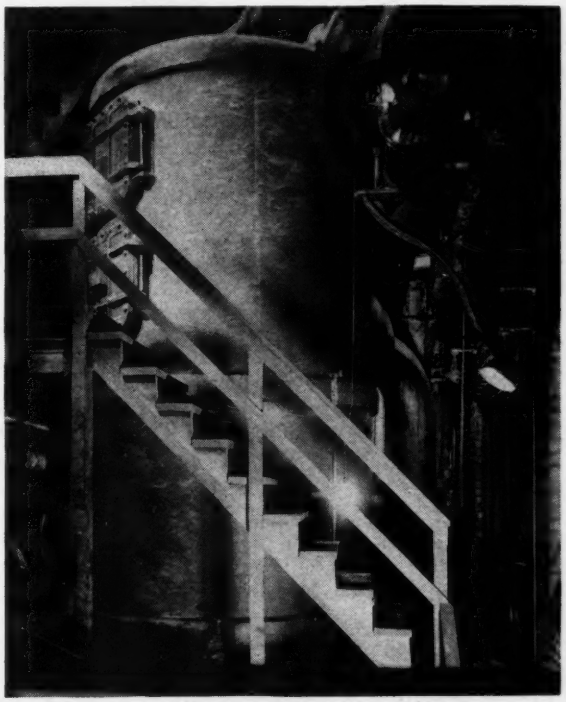
One reason why I am so much concerned about saving exhaust steam is that, as I see it, fuel is the most important substance in the world. It surpasses diamonds, platinum, radium, gold—everything else—in value. No material saving is more important to civilization than that of fuel. Our greatest concern for future generations should be the almost pitiful rate at which fuel is being wasted in our modern manufacturing processes, in our transportation, and in heating buildings.

It is not so wasteful to buy a hundred times more clothes than we need because we are helping the other fellow in so doing. It is not so wasteful to buy ten automobiles per year if we want to and if we can pay the bills. The only real waste is the fuel loss. In the manufacture of clothes and cars there is an irretrievable loss of a certain amount of fuel. That is the one and only lamentable thing. Iron can be melted and remelted over and over and therefore is not wasted. The great waste is the fuel loss. Cotton, wool, food products, and the like, can be wasted recklessly without endangering future supply. But that is not true of coal, oil, and natural gas. After burning, they are gone forever. Exhaust steam going to waste is a certain portion of this most valuable substance escaping from us for all time.

Newark, N. J. W. F. SCHAPHORST.

Making New Boilers Out of Old

THE ARTICLE under the above title in the August issue describing the new power plant at the Castanea Paper Co. at Johnsonburg, Pa., led the Elliott Co. of Jeannette, Pa., to send in the accompanying picture



of the 360,000 lb. per hr. Elliott deaerating heater installed at that plant. Tucked away in a dark corner of this plant the installation of this heater required all but the proverbial "shoe horn," yet it does its work as effectively as though it were out in the open.

Philosophy of Tubes

WHEN MY AUGUST issue of POWER PLANT ENGINEERING arrived last week I turned to the Table of Contents with keen anticipation. Imagine my surprise when, from the middle of the page, there sprang at me the unusual caption, "Election Tubes—Their Principles and Applications."

Before turning the pages to the article itself I paused. What possibilities such a story possessed! Would political questions, by chance, be discussed, with all their charges and counter charges; their claims and counter claims? Would there confront one in the pages of POWER PLANT ENGINEERING an economic and social discussion that would set the engineering world thinking as a unit, along social lines? What an opportunity, I thought, for dealing with the relation of engineers to elections; scientists in the realm of politics!

Then I found it was all a mistake. A printer had merely made a type-setting error! Instead, I found an interesting discussion of the new and important uses of the electrical tool of science—the Electron Tube. It was complete, clearly written, informative.

Then I reverted to the Table of Contents again. "Why doesn't someone really write about an Election Tube?" I asked. The tubes I found described in the article conduct through space by the free motion of electrons, and other freely moving parts. How did that parallel the free movement of men's brains at elections? Does the mind of man really move freely, conducted and controlled by intelligence? Or do ward-heelers, devoting their lives to exploiting the tax-payer, control by the propaganda of pure baloney and bunkum? Why doesn't someone come along and actually invent an Election Tube? What an honorable and everlasting tribute it would be to the engineering profession—to rid the world of political poppycock; to debunk the purveyors of baloney forever!

The debunking device of my imagination would be an Election Tube produced by engineers. It would, by its miraculous operation, enable every citizen in the country to know the true facts about political campaigns and platforms. Senator Who's Itz, promising leisure for all, and free fortunes for the asking, would find himself cornered like a snake. Governor What-Not, of "No Work—All Pay" fame would be immediately thrown into a state of complete dis-use. This would be because the Tube, knowing truth, knows that income, for both labor and capital, depends upon work. It's as plain as the fact that your boiler produces steam only when fuel is thrown into the fire-box.

I carried the picture even further; let it expand as it would. I dreamed of a Mammoth Election Tube —a Master Tube—erected in the vaulted rooms of the Bureau of Standards or the Smithsonian Institute. Its searching readings of the honesty and integrity of candidates would be reported accurately and without emotion to a corps of pure scientists. (The operators would be kept in bombproof cells!) At every important election the Great Tube would swing into action like a cannon, mowing down with its all-seeing beams, the unfit, the irresponsible, the selfish, the greedy, and the dishonest. The findings of this Master Tube would be flashed through the ether to the four corners of the land. Voters, convinced beyond question of the infallible nature of its readings, would be waiting in every balloting place in the country, guided by the Great Invention of Truth in politics—the Election Tube of the engineer.

Then I woke up and came to my senses. Engineers are such modest beings! Besides, would there be any candidates left to run?

Seriously, for a moment. Could not all this be done literally (if not so figuratively) by the thoughtful, intelligent application of engineering soundness to economic problems? Isn't each engineer dedicated to truth in everything he tackles? In his own locality, in his own circle of friends, each of us is a force for straightforward thinking. Why not use it actively, through leadership in our own communities, for the high purpose of debunking the bunkers; for continuing to help build our great democracy of government?

It's a tough job, but somehow it seems worth tackling!

Waterbury, Conn. L. M. DUREE.

The Effect of Unconsumed Carbon on the Volume of Flue Gas

THE WRITER has made some calculations concerning the volume of flue gas discharged to the stack that is produced from the combustion of a coal, when there is no unconsumed carbon and when there is a 2 per cent loss and also a 10 per cent loss. Besides the products of combustion, the gas contains the H_2O vapor brought in with the air supplied and the vapor from the steam admitted by the soot blowers. While the amount of the latter has been assumed as constant in all cases, it is included, as its presence has an effect on the partial pressure of the H_2O vapor in the gas and for the sake of accuracy in determining the volume of the wet gases.

For each condition of carbon lost, the flue gas analysis has been calculated, as well as the heat balance, upon the bases, as follows:

(a) That the dry gas has a content of 14.65 per cent of CO_2, by volume. The results are given in the upper line of each item in the table.

(b) That the excess air amounts to 26.59 per cent. The results are given in the lower line of each item in the table.

Consolidated Table of Results

	Items		% of Carbon Unconsumed		
			0	2	10
1	Efficiency, from the heat balance, %	(a)	85.07	83.56	77.54
		(b)	85.07	83.54	77.45
2	Loss due to unconsumed carbon, as reflected in the heat balance, %	(a)	0.00	1.67	8.36
		(b)	0.00	1.67	8.36
3	Mols of wet gas per lb. of coal	(a)	0.50380	0.49435	0.45623
		(b)	0.50380	0.49530	0.46150
4	Heat available for steam production per lb. of coal Btu,	(a)	12,190.0	11,973.7	11,111.4
		(b)	12,190.0	11,971.4	11,098.9
5	Lb of coal required to equalize steam production ("unit weight"),	(a)	1.	1.0161	1.0971
		(b)	1.	1.0183	1.0983
6	Mols of wet gas per "unit weight" of coal producing like amounts of steam,	(a)	0.50380	0.5033	0.50053
		(b)	0.50380	0.50436	0.50687
7	Cu. ft. of wet gas, at 425 F, per "unit weight" of coal producing like amounts of steam	(a)	325.34	325.02	323.23
		(b)	325.34	325.70	327.32

Items 5, 6 and 7 are based on the supposition that in all cases the same amount of steam is to be generated.

The upper line values of Item 7 of the table show that on the basis of a constant percentage of CO_2 (meaning with a variable percentage of excess air), for all three carbon-loss conditions, the volume of wet gases decreases as the percentage of carbon loss increases. While on the basis of a constant percentage of excess air (meaning with a variable percentage of CO_2), the volume of wet gases increases as the carbon loss increases, as shown in the lower line values of Item 7.

To arrive at the exact volume of wet gases, it is necessary to carry through a complete set of calculations, under the operating conditions.

Redondo Beach, Cal. HERBERT S. KIMBALL.

Motorizing A Hand Sump-Pump

In a Factory outbuilding, a simple pitcher pump had been installed to act as a sump-pump. Pumping the pit was a boresome and time-wasting job but the location hardly warranted the purchase of a modern electric sump-pump, so a motor drive was devised, using spare equipment already on hand, supplemented by a few simple parts made in the factory machine-shop. The construction of such a unit is simple, and with modifications may be made to serve in many ways.

Cut off the handle of the pump at a convenient distance beyond the rocker-pin and to the portion remaining, clamp a length of Shelby tubing, 25/32 in. I. D. by 1¼ in. O. D. Procure a piece of ¾ in. round cold-rolled steel and weld a turned steel ring to one end to form the connecting rod. This ring should be made up ⅞ in. thick, 1 in. I. D., 1¾ in. O. D.

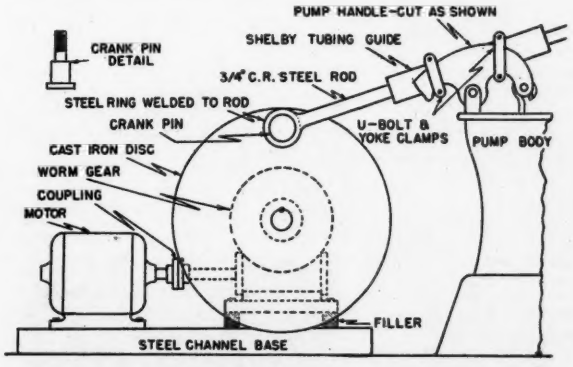
Have cast or pick up at a foundry a cast-iron disc 12 in. dia. by ¾ in. thick with a generous hub at the center. Near the outer edge drill a ¾ in. hole for the crank-pin, and bore and keyset a hole at the center to take the low speed shaft of the reduction-gear. The worm reduction-gear should be of at least ½ hp. at 1800 r.p.m., with a ratio of about 30 to 1 so as to operate the pump at 60 strokes per min.

The crank-pin must be turned from a piece of steel 1⅜ in. dia. by 2¾ in. long. Leave an outer flange of ¼ in. and turn the body for a length of 15/16 in. to a diameter which will fit snugly but easily into the connecting rod ring. Then turn the remaining length to ¾ in. dia. and thread. Then procure a ¼ or ½ hp. motor and couple it through a flexible coupling directly to the high-speed shaft of the worm gear. Align the motor and gear carefully on a suitable length of 8 in. std. steel channel and bolt down.

When attaching the drive to the pump some experimenting may have to be done to find the best relation of the power unit to the pump itself. As the distance between pump-center and disc-center increases, the pump-stroke will shorten and the required power will be small. Conversely; as the power-unit is moved toward the pump the stroke will lengthen, a greater amount of water will be lifted and more power will be used.

With a float-switch installed to control the motor this unit as described has served continuously for 2 yr., with no further attention than a regular oiling, and is now in perfect condition.

West Warwick, R. I. James P. Marshall.



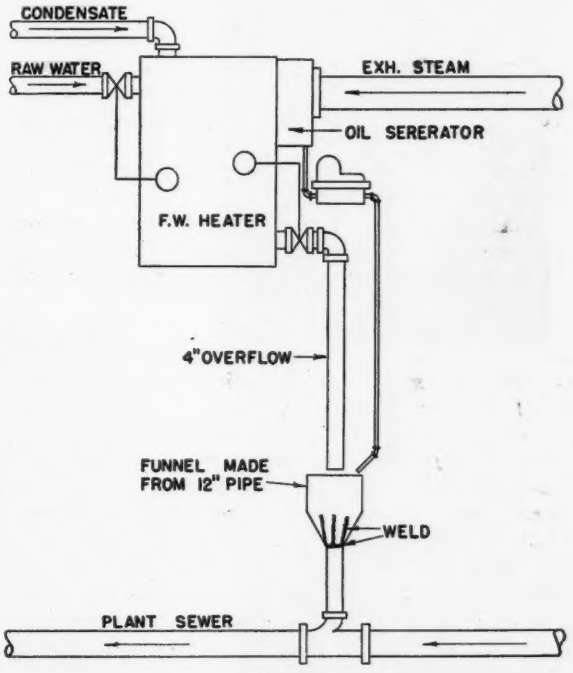
If you have the materials and lots of time try this. If you haven't you can save money by buying a new sump-pump. The arrangement for converting rotary to reciprocating motion is however unique and may be of service in other locations where space does not permit the use of the more conventional crosshead

Visible Overflow for Feedwater Heater

Satisfactory plant operation is always enhanced by increasing the accessibility and visibility of various pieces of equipment.

Considerable inconvenience and incidentally considerable heat loss was experienced in one plant by the feedwater heater overflowing; this was usually caused by the float valve on the raw water line sticking or by the overflow valve leaking.

During the heating season, when all of the available exhaust was needed for heating, this loss became quite serious and since the overflow was connected



Heater Overflow Made Visible

directly to the sewer, this loss was not immediately apparent to the operator and would continue unnoticed over a long period of time.

To correct this condition, the 4-in. overflow line was cut and a large funnel made of 12-in. pipe was inserted in the line, so that the overflow would always be visible.

With feedwater at 210 deg. F. there would be quite a large discharge of steam due to flashing and the operator's attention would be drawn immediately and he could take the necessary corrective steps.

Such visible overflows should be installed on heater and tank overflows and trap discharges when the vapor will not be particularly objectionable.

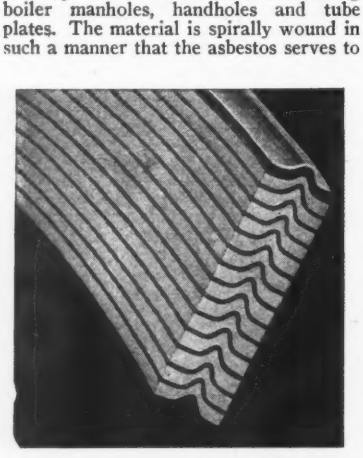
Rochester, N. Y. Julius Brodsky.

New Equipment

Information that you desire about any equipment will be gladly furnished without obligation. WRITE POWER PLANT ENGINEERING.

Spirotallic Gaskets

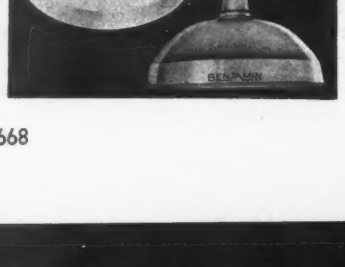
To MEET service conditions on modern power plant equipment operating at high pressures, Johns-Manville, 22 East 40th St., New York, N. Y., has developed a new type of gasket constructed of preformed plies of asbestos and cold-rolled, cadmium-plated steel. Known as the "Spirotallic Gasket" it is for sealing boiler manholes, handholes and tube plates. The material is spirally wound in such a manner that the asbestos serves to



seat the adjacent, interlocking metal plies. As soon as compression is encountered, the strong, rigid edges of the plies meet the bearing surfaces of the manhole, handhole or tube plate to form a series of metal barriers that provide a tight and effective seal against extreme pressures and high temperature conditions. Spirotallic manhole and handhole gaskets are available in standard sizes in both round and oval form. The sizes of Spirotallic tube plate gaskets vary according to the boiler. This material is supplied in ⅛, $\frac{5}{16}$ and ¼-in. thicknesses.

Eye Comfort Emphasized By New Lighting Unit

A NEW LIGHTING reflector specifically designed to utilize the indirect lighting characteristics of the silvered bowl mazda lamp, and thus provide a greater degree of eye comfort at relatively low cost, has just been placed on the

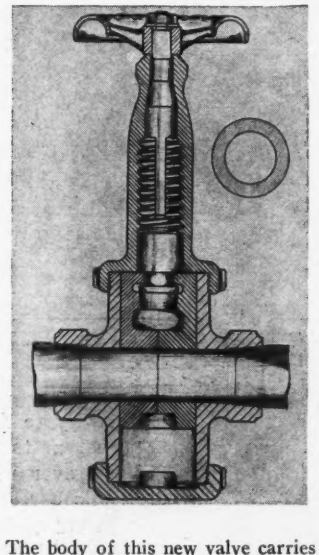


market by the Benjamin Electric Mfg. Co., Des Plaines, Illinois.

Known as the Benjamin RLM "Silvered Bowl" Diffuser, the new unit makes more effective use of the silvered bowl lamp by a distinctive innovation in diffuser design. Through the proper combination of porcelain enamel and Alzak aluminum reflecting surfaces and the use of the silvered bowl lamp, a softer, better diffused illumination is secured without sacrificing high lighting efficiency.

Packless Valve

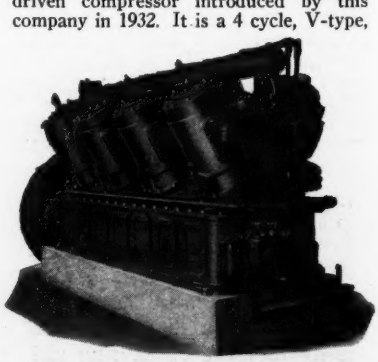
THE MONAT VALVE AND FORGE CO., 1007 Bessemer Bldg., Pittsburgh, Pa., has recently developed a packless, cylindrical gate valve, suitable for high as well as low pressures and temperatures. This new, rugged valve, designated as the Monat "Stream-Flow" contains the salient construction features of both gate and plug valves. There are no cavities and friction is eliminated. It is available in sizes ranging from ½ to 8 in. in the standard metals. Also in special metals and alloys for lines handling corrosive liquids and gases.



The body of this new valve carries a cylindrical bore, at right angles to the line of flow. A cylindrical gate is moved up and down by means of a screw in the valve bonnet, and is prevented from turning by a key in the cylindrical bore. The run of the valve conforms in shape and size to that of the pipe—namely, that it is circular. No packing is required. The only operating part in the line of flow is the gate itself. A cap on the bottom of the body and the removable bonnet permit cleaning the valve while it is in the line.

Gas Engine

TYPE PVG gas engine, designed for use wherever gas is available as a fuel, was shown for the first time at the International Petroleum Exposition at Tulsa in May by the Ingersoll-Rand Co., 11 Broadway, New York, N. Y. This engine is a logical development to supplement the popular XVG gas-engine-driven compressor introduced by this company in 1932. It is a 4 cycle, V-type,

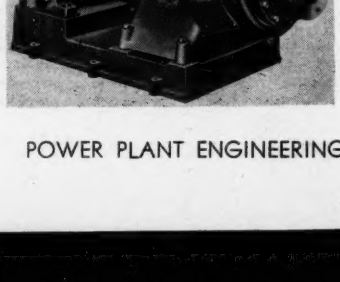


multi-cylinder engine, built for continuous full load operation at the moderate speed of 400 r.p.m. Available in three sizes of 4 cylinder 185 hp., 6 cylinder 275 hp. and 8 cylinders 370 hp., it has the same cylinder arrangement and cylinders as the XVG and is manufactured in the same plant with the same jigs and tools.

Centrifugal Pump

LAWRENCE PUMP & ENGINE CO., Lawrence, Mass., announces a single stage, side suction, centrifugal pump for general industrial use. This unit is an especially rugged and heavy duty design for general industrial pumping. Sizes range from 1½ to 18 in. discharge; capacities from 10 gal. per min. to 15,000; heads up to 300 ft. in the smaller sizes.

Pump casing are of solid volute type with removable suction head. Eccentric nozzle on suction head permits removal without disturbing discharge pipe or pump alinement, also eliminates air pockets. Impeller is enclosed type, cast in one piece, balanced, and locked on shaft by long key and non-rust impeller nut. Supporting bracket and pump casing are separate parts with machines male-

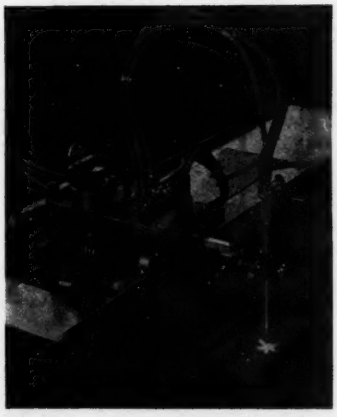


female fit between to insure perfect alinement. As a further precaution to give accurate alinement the male-female joint and bearing seats on supporting bracket are machined in one operation.

Two heavy duty, double row ball bearings, lubricated by an oil reservoir, and entirely external from pump, support the shaft. Bearing nearest pump carries radial load only and is self aligning. Outer bearing of angular contact type carries thrust and radial loads. Packing gland is of bronze and is split, two-piece interlocking type that may be easily and completely removed when packing stuffing box.

Portable Oxy-Acetylene Cutting Machine

THE LINDE AIR PRODUCTS CO., 205 East 42nd St., New York, N. Y., Unit of Union Carbide and Carbon Corp., announces the Oxweld (Type CM-15) portable shape-cutting machine, the latest addition to its line of portable cutting machines. The machine weighs less than 200 lb. complete. All controls of the machine are conveniently located adjacent to one another. The cutting area



—that is, the maximum range of blowpipe movement—is 60 in. lengthwise and 18 in. laterally. Cutting speed can be varied from 3½ to 28 in. per min., and a speedometer indicates movement directly in inches per minute.

Accurate results can be obtained within the operating limits of the machine because of careful and precise construction. Templet-tracing, hand-tracing, automatic circle-cutting, and straight-line cutting are all within the scope of operation of this machine. Any desired shape within the range of the machine can be automatically cut by the use of templets. A straight-line cutting guide is used for straight-line cutting in any direction. Circles from 2 to 18 in. in diameter are cut by the use of the circle-cutting attachment.

Hand-tracing is accomplished by guiding the tracing wheel over a blueprint or drawing. Bevel-cutting up to an angle of 45 deg. can be done in either direction by merely shifting the angle of the blowpipe. In addition, a supplementary blowpipe bar, which is furnished with the machine, permits the use of two blowpipes for simultaneous cutting of similar shapes.

Capacitors

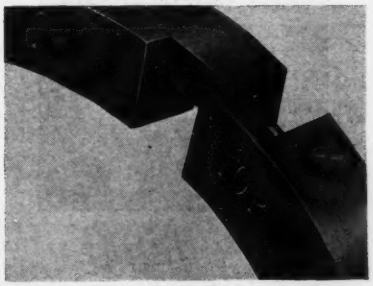
HERMETICALLY sealed in round aluminum containers, the Type TLA new capacitors made by Cornell-Dubilier Electric Corp., South Plainfield, N. J., are impregnated and filled with fireproof Dykanol, the same high dielectric impregnant as used in the TJ-U transmit-

ting capacitors. The capacitors are well suited for dependable operating in high power amplifiers and medium powered transmitters. Physical size and shape of the containers of these capacitors simulate electrolytic capacitors, allowing for simple and neat assembly into power unit. The staple characteristics of Dykanol permits the operation of these capacitors at 10 per cent above rating without injury to unit.

Piston Ring

MADE by Wilkening Mfg. Co., Philadelphia, Pa., the Seal Cut design of Pedrick piston ring provides for a positive and permanent seal at the cut or gap of the ring. A perfectly matched lap prevents any leakage past the ring at the cut, either down the cylinder bore or around the ring groove.

Wear of the cylinder walls does not affect this seal, because the cut is lapped far enough to take up all the opening which wear may cause. The design and



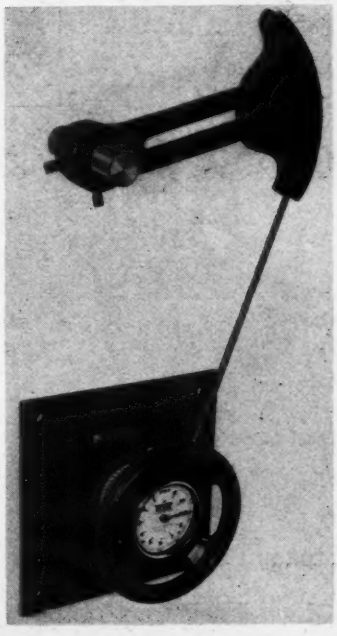
construction of the cut makes for extra strength. There are no thin cross-sections, no fragile tip to break.

Pedrick Seal Cut rings are made in all sizes for air compressors, pumps, gas engines and oil engines. The Seal Cut design is heat-shaped, a patented process which insures roundness or equal distribution of radial pressure throughout the circumference of the piston ring. This process also provides a black iron-oxide coating on all Pedrick rings.

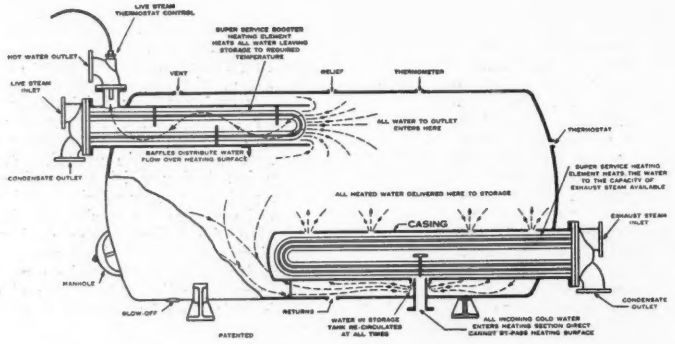
In addition to the iron-oxide coating resulting from this heat-shaping process, the piston ring can be had with the special Pedrick Silcoat finish which gives quicker seating and eliminates any possibility of scuffing of the cylinder walls during the wearing-in period. This is the period during which exhaustive tests show that most wear of rings and cylinder walls occurs. The slightest irregularity of the cylinder bore during this period causes "blow-by" of compression which leaves a rough surface on rings and cylinder walls. The "Silcoat" finish on Pedrick Seal Cut piston rings takes care of this.

Damper Controller

TEFFT-JACKSON, INC., 2 Allens Ave., Providence, R. I., has supplemented its line of valve position indicators with the new Tejax indicating damper controller for hand operation. The manual controller provides precise damper settings indicated by a bold face dial and pointer, which enables the operator to make compensating damper movements with accuracy in relation to changes in fuel supply to meet swings in boiler load demand. The dial pointer makes it possible for the operator to return to an exact pre-

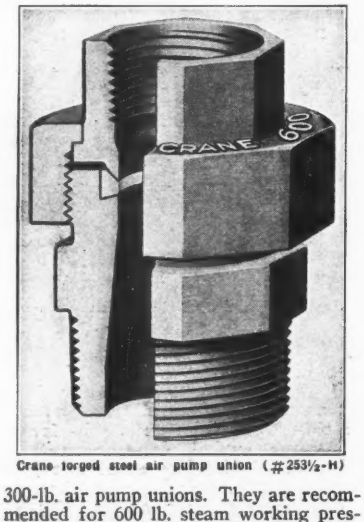


determined damper setting with ease. The indicating damper controller is easily mounted on either the front or the side of the boiler, and operates the damper by means of an adjustable eccentric quadrant connected to the controller by cable. The eccentric adjustment provides the means of obtaining a predetermined ratio of air to the dial readings. In combination with the Tejax indicator control valve, proportionate fuel flow and air flow settings can be obtained to match in correct volume to give better combustion efficiency with a resultant higher CO_2 per cent.


LIVE STEAM THERMOSTAT CONTROL
SUPER SERVICE BOOSTER HEATING ELEMENT HEATS ALL WATER LEAVING STORAGE TO REQUIRED TEMPERATURE
HOT WATER OUTLET
VENT
RELIEF
THERMOMETER
LIVE STEAM INLET
ALL WATER TO OUTLET ENTERS HERE
THERMOSTAT
BAFFLES DISTRIBUTE WATER FLOW OVER HEATING SURFACE
CONDENSATE OUTLET
SUPER SERVICE HEATING ELEMENT HEATS THE WATER TO THE CAPACITY OF EXHAUST STEAM AVAILABLE
ALL HEATED WATER DELIVERED HERE TO STORAGE
CASING
EXHAUST STEAM INLET
MANHOLE
BLOW-OFF
RETURNS
WATER IN STORAGE TANK RE-CIRCULATES AT ALL TIMES
ALL INCOMING COLD WATER ENTERS HEATING SECTION DIRECT CANNOT BY-PASS HEATING SURFACE
CONDENSATE OUTLET
PATENTED

Forged Steel Unions

ANNOUNCEMENT is made by Crane Co., Chicago, of a new line of forged steel air pump unions constructed for high pressure lines subject to piping strains and vibration, expansion and contraction. These unions conform to the specifications and recommended practice of the Association of American Railroads for



Crane forged steel air pump union (#253½-H)

300-lb. air pump unions. They are recommended for 600 lb. steam working pressure at 550 deg. F. and for 2000 lb. cold water, oil or gas, non-shock.

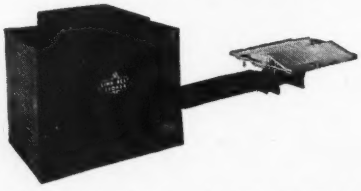
These unions are made in reducing sizes and have male and female ends. The brass to steel ground joint seat is non-corrosive and holds pressure without a gasket. The unions are designed to be taken apart and reassembled repeatedly without affecting strength or tightness.

Stoker

A NEW model commercial stoker, designated as the No. 15, has been put on the market by Link-Belt Co., Chicago, Ill. It is designed to burn a wide variety of bituminous stoker coals, and will handle 3500 sq. ft. of radiation.

The hopper is entirely enclosed; the front compartment housing the fan, motor, transmission and air-meter (automatic air control). The shear pin on the transmission is equipped with a "Load-Signal" which announces when the pin shears, in case an obstruction should get into the feed tube.

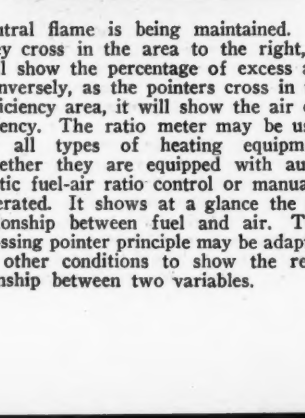
The burning head is the "Power-Flex" type, which features laminated tuyeres with primary and secondary air ports. No dead plates are used. With this design, an active fuel bed is maintained over practically the whole area of the furnace; with consequent higher efficiency and capacity. The Power-Flex head will burn both low-fusion, non-caking bituminous coals and high-fusion,



caking and coking coals. Flexibility to meet local boiler conditions is secured by the use of various length tuyeres.

Ratio Meter

THE NEW direct reading Askania Ratio Meter, an unusual and practical development in instrumentation has just been announced by the Askania Regulator Co., 1603 South Michigan Ave., Chicago, Ill. It consists of two flow metering elements, one for air and one for gas. The pointers shown are arranged to cross in the chart area so that the intersection of the pointers indicates the relation between the two flows. As long as the pointers cross on the vertical or zero line, it shows that a



neutral flame is being maintained. If they cross in the area to the right, it will show the percentage of excess air. Conversely, as the pointers cross in the deficiency area, it will show the air deficiency. The ratio meter may be used on all types of heating equipment whether they are equipped with automatic fuel-air ratio control or manually operated. It shows at a glance the relationship between fuel and air. This crossing pointer principle may be adapted to other conditions to show the relationship between two variables.

Storage Heater

NATIONAL Super Service Storage Heater manufactured by the National Pipe Bending Co., New Haven, Conn., is a new type of patented storage heater embodying entirely new design and construction. Entering water passes directly into a casing completely enclosing the heating element. Thus all of the water comes in intimate contact with all of the heating surface at all times.

Adding a super service booster unit in the upper zone of the heater near the outlet guarantees the final temperature of the water when exhaust or low pressure steam is not up to requirements.

2500-lb. Safety Valve

THE CONSOLIDATED Safety Valve Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn., announces the completion of a new line of safety valves for elevated pressures and temperatures (2500 lb. at 1000 deg. F.).

Special alloy steels with low coefficients of expansion have been selected for the bodies, bonnets, springs and trim so that these valves will provide the same safe performance at this new high in operating conditions that is regularly pro-

duced in safety valves for 300 lb. boilers. Bodies and bonnets are assembled with through bolts to prevent "freezing" at high temperatures. The trim of these valves is treated stainless steel. Constant seat diameter is insured by a new type of bevel seat in which the actual contact bearing between the seat and disc is always at the lowest portion of the seat surface. The single ring type of blowdown control is used. Note the thickness of the inlet flange, which is the new 2500-lb. standard.

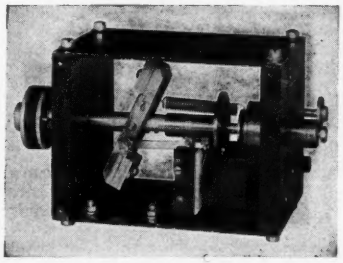
Diesel Generator Set

THE MURPHY DIESEL COMPANY, LTD., of Milwaukee, Wis., has announced the addition of a generator set to their line of engine equipment. These are offered in two sizes, a 4-cylinder engine delivering 45-55 KW and a 6-cylinder engine delivering 65-85 KW. Either AC or DC current is available and units can be supplied complete with the generator built into the flywheel housing or separate and driven through a flexible coupling. When desired, generator sets can be set up in tandem.

Centrifugal-Speed Relay

A NEW CENTRIFUGAL-SPEED relay for controlling practically all types of rotating machinery in the speed classifications between 70 and 4000 r.p.m., has been announced by the Central Station Department of the General Electric Company. Designated Type GCR-10, the new relay may be set to indicate either excessively high or low speeds or both, and for synchronous-speed indication as well.

A feature of the new GCR-10 relay is that it is adjustable in operation. Cali-



bration within range of the relay may be made without stopping the machine.

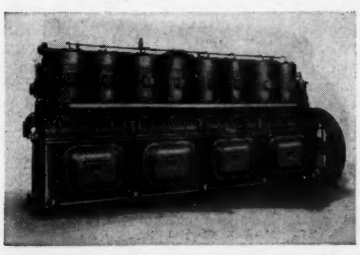
The new relay may be mounted vertically or horizontally, and will operate with clockwise or counterclockwise rotation. Maintenance is negligible inasmuch as it has no current-carrying brushes and slip rings to service. Its sealed ball bearings require no lubrication.

Rotor mechanism consists of the rotor proper, with variable detachable weights, balancing spring, and contact-tripping linkages. The mechanism is mounted on a strong steel shaft supported by sealed ball bearings. An insulated flexible coupling allows for end play of the driving shaft and any slight misalinments that may occur in mounting. In addition, the coupling serves as an insulator to prevent shaft currents from passing to the relay.

Switches mounted on the stationary part of the relay are separately adjustable in position, and are readily interchangeable to provide either automatic or manual reset.

Vertical Gas Engine

WORTHINGTON PUMP & MACHINERY CORP., Harrison, N. J., announces the latest addition to the extensive line of gas engines to be known as the Type LPE. The new engine is of the vertical four-cycle design, a power unit arrangement of the popular LCE gas engine compressor unit. With the exception that frame extensions and running gear for the compressor cylinders have been omitted, the units are similar and all component parts are interchangeable between them.

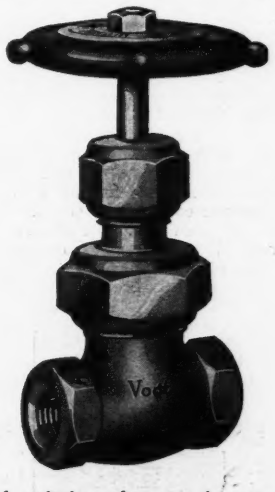


The LPE engine is of the multi-cylinder, trunk-piston type with cylinders of the L-head design arranged in line. The entire unit is totally enclosed and has full circulating pressure lubrication throughout. The straight-line arrangement of cylinders provides utmost accessibility and permits equal intervals between power impulses. This latter feature produces the most uniform turning effort and smoothest operation with a very small flywheel. A single magneto can be used for all cylinders. Units are available in four, six and eight cylinder arrangements, conservatively rated at 180, 270 and 360 br.hp. when running at 400 r.p.m.

Meter Valves

THE HENRY VOGT MACHINE CO., Louisville, Ky., announces a line of drop forged steel, union bonnet type, meter valves in ¼, ⅜ and ½ in. sizes, especially suited for applications where close, dependable and safe regulation is important.

This type valve has numerous features, such as hexagon body ends, a ground joint between body and bonnet, a stem that can be easily reground or re-

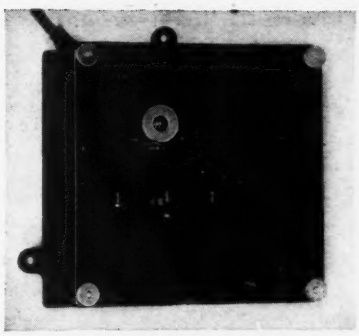


placed and the valve may be repacked under pressure. Recommended for 900 lb. W. P. at 750 deg. F. or 1500 lb. non-shock cold working pressure and may be had of all-carbon or all-stainless steel to suit.

Air-Operated Cycle Controller

A NEW single-cam cycle controller that provides for the control of as many as four separate operations is now being built by The Bristol Co., Waterbury, Conn. These instruments are for process manufacturing, being extensively used in vulcanizing rubber products and in plastic molding.

The cam is designed to be cut so that it will meet a wide variety of requirements. Additional flexibility is provided through the use of adjustable segments. These instruments also have a special operating mechanism which makes it possible to obtain two different speeds of rotation before the cam completes a cycle. They are equipped with patented

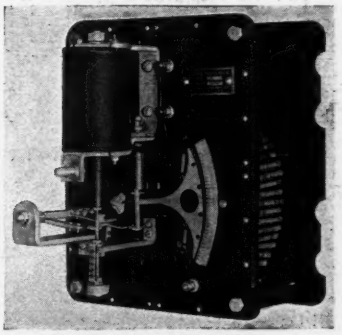


three-way leakless pilot valves, which eliminate the need for a fixed air leak at the controller.

The instrument cases are moisture- and dust-proof and the switches that control the electrical circuits in the controller are enclosed, as is the motor, and the finer mechanisms are not exposed to any of these detriments to operation.

Rocking Contact Voltage Regulator

ALLIS-CHALMERS MFG. COMPANY'S Switchgear Division, Milwaukee, Wisconsin, has come out with a new simple, inexpensive "Rocking Contact" type voltage regulator, known as their type V-O, designed for automatic voltage control of small alternating and direct current generators. This proven design of regulator was heretofore available only in the larger, more expensive Rocking-Contact-Principle regulators. This same principle being incorporated in the new V-O regulator, it is quick acting, regulating the voltage by directly varying the resistence in the field circuit.



The type V-O regulator consists of a sensitive solenoid actuated plunger which acts upon a main shaft, rocking a special carbon rimmed contact sector over the inner surface of the commutator, the segments of which are connected permanently to the regulating resistance. The segments are heavily silver plated in order to insure positive contact surface, and are insulated one from another and solidly held in place on a specially constructed base to prevent any disalinment through years of service. Only two simple adjustments to be made at the time of installation, since all major adjustments are made at the factory.

The regulator is of small dimensions and suitable for either switchboard or wall mounting.

Pulverized Coal Steam Generator

THE KENNEDY Pulverized Coal Steam Generator proper consists, briefly, of two drums connected by a system of bent tubes consisting of both boiler and water walls. The two drums are located one above the other with varying distances between horizontal centers and are connected by boiler tubes arranged in semi-vertical positions. Water wall tubes are so arranged as to completely enclose the furnace on three sides as well as the roof and floor and connect the water wall headers directly with the top steam and water drums. The feeder and floor tubes connect the water wall headers directly with the bottom water storage drum.

The generator is fired by the Kennedy system of pulverized fuel firing comprising a Kennedy Air Swept Tube Mill, feeder and exhauster, and turbulent type burners equipped with supercharger. These burners afford a ratio of operation of 24:1 allowing a wide range of operation to meet fluctuating demands.

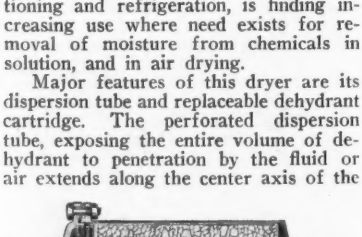
The following are average performance figures on a 450 lb. per sq. in. Kennedy pulverized coal steam generating unit having 5,726 sq. ft. of heating surface in boiler and water walls, when developing 50,000 lb. steam per hr.

Overall efficiency on test witnessed by impartial engineers, 87.967 per cent; average monthly efficiency, over 85 per cent; fineness of pulverized coal delivered to burners, 85 to 95 per cent through 200 mesh. Kennedy-Van Saun Mfg. & Eng. Co., New York, N. Y.

Dehydrator

THE NEW Henry Cartridge Dehydrator, made by the Henry Valve Co., 1001-19 North Spaulding Ave., Chicago, Ill., originally designed for air conditioning and refrigeration, is finding increasing use where need exists for removal of moisture from chemicals in solution, and in air drying.

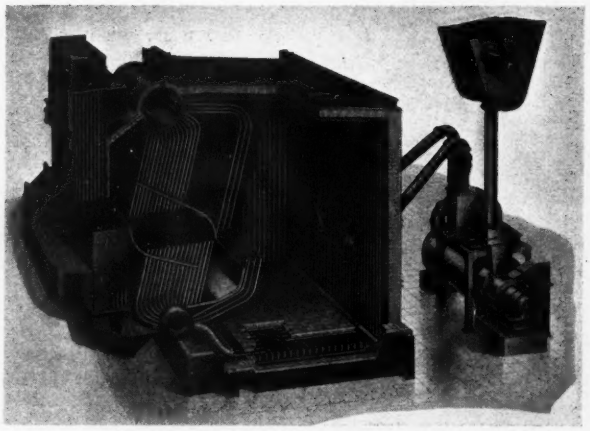
Major features of this dryer are its dispersion tube and replaceable dehydrant cartridge. The perforated dispersion tube, exposing the entire volume of dehydrant to penetration by the fluid or air extends along the center axis of the



dehydrant column. This construction is claimed to reduce the pressure drop, prevent channeling and resultant loss of efficiency. A strong compression spring provides positive sealing of dispersion tube to inlet fitting, preventing by-passing between outside of dehydrant cartridge and inner surface of dehydrator shell.

Every trace of moisture is removed from these dryers and replaceable cartridges by the Henry vacuum process. The dryers are then sealed with dehydrated air, insuring absolute dryness until the moment seal cap is loosened for installation.

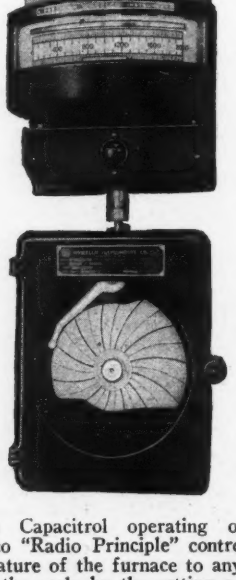
Refill cartridges make recharging of these Henry dryers exceptionally simple and easy. Cartridges are available



charged with activated alumina, drierite, barium oxide, calcium oxide or anhydrous calcium chloride, at the same cost. The flange shell construction of the dryer, which is distortion-proof, speeds removal and replacement of cartridges. Obtainable in complete range of capacities.

Wheelco Program Control

MADE by the Wheelco Instruments Co., 1933 So. Halsted St., Chicago, Ill., this Program Control consists of the program unit and a Wheelco controller mounted integrally. To the temperature control setting pointer of the Wheelco Capacitrol is attached an idler arm which rides on the edge of the contoured disk of the program unit. The program disk is rotated by a synchronous motor through a gear reduction.



The Capacitrol operating on the Wheelco "Radio Principle" controls the temperature of the furnace to any point set on the scale by the setting pointer; thus with the Program Control, the temperature at which the Capacitrol controls is governed by the position of the idler arm on the program disk over any desired period of time.

The contoured disk can be cut to any time cycle desired with any variation of temperature control. The disk can be easily removed and replaced by other contoured disks to suit any required heating program.

Electrolytics for A.C. Motor Starting Application

CORNELL - DUBILIER ELECTRIC CORP., South Plainfield, N. J., announces Type JDF electroyltic capacitors for motors and other a.c. applications. They are hermetically sealed in lock seamed aluminum containers and equipped with a special bakelite terminal block having two dummy screw terminals. Terminals are arranged for convenient wiring to motor, line and thermostat, in refrigerator applications.

These high capacity dry electroyltic a.c. capacitors are designed for the many a.c. applications, such as motor starting during the starting cycle of the motor, where high capacity is necessary for intermittent use, and for operation involving a maximum of 20 starts per hour, each start of 3 sec. duration. C-D Type JDF electroyltics are recommended for use with fractional horsepower motors of the type used in refrigerators, oil burners and similar appliances.

FOR COMPRESSORS, where maximum demand is intermittent and continuous demand light, a selective electrical regulator has been devised to control air output according to usage. For maximum capacity, the synchronous-motor-driven compressor runs continuously, the compressor being loaded or unloaded to maintain air pressure at 98 to 100 lb. When the compressor unloads and the "sampling" feature indicates low air usage, the motor stops and restarts only when pressure has dropped some 10 lb. Sullivan Machinery Co., Michigan City, Ind.

News from the Field

J. W. MERIAM, for the past 24 years, vice president and secretary of the Lincoln Electric Co., Cleveland, Ohio, has retired from active service with the company, but will remain as a director. Announcement was also made that A. F. Davis, vice president was elected secretary.

CARL L. PFEIFER, Treasurer of the Chain Belt Co., Milwaukee, died suddenly, August 24 in Philadelphia, Penna. Mr. Pfeifer was born in Chicago, Illinois in 1880, where he received his education. In 1914, he was employed by the Chain Belt Co. as comptroller after leaving the employ of Arthur Young & Co. In 1916, he was elected treasurer of the Chain Belt Company, a position which he held until his death.

THE LAMP DIVISION of the Hygrade Sylvania Corp., Salem, Mass., has just placed orders for new machinery at an approximate cost of $50,000. Orders previously placed by this corporation this year for new machinery amounted to more than $100,000.

BRIDGEPORT BRASS Co. completed this month a new rolling mill at Bridgeport, Conn., for the production of brass, copper and copper-base alloys for industrial and commercial use. Built at a cost of more than $4,500,000, the new plant, in which all rolling mill operations of the company will be located, marks the completion of the first major step in a long-range expansion and modernization program which was inaugurated early in 1937, according to an announcement by Ralph E. Day, president and general manager of the company.

FRANK D. NEWBURY has been appointed manager of the New Products Division of the Westinghouse Electric & Mfg. Co. Mr. George H. Bucher, president of the company, announced his appointment as successor to Herbert Mygatt Wilcox who died July 28. In addition to this development of activities for Westinghouse in new fields, Mr. Newbury will continue his present duties as Economist for the company.

C. PARKER HOLT, Vice-President and Director of Caterpillar Tractor Co., and for nearly 40 yr. affiliated with it and one of its predecessors, the Holt Manufacturing Co., died the morning of August 24th at his home in Piedmont, California.

Born in San Francisco April 5, 1880, Mr. Holt was the son of Charles H. Holt, who with his brother, Benjamin, developed the Caterpillar track-type tractor at Stockton, California.

J. C. BARNABY, former manager of Worthington Pump and Machinery Corporation's Oil and Gas Engine Application Division at Buffalo, New York, and responsible for engine sales in the Central Division, is now in charge of special engineering work covering engine research and design, and will devote his entire time to this activity. W. E. Wechter, in charge at New York of the Corporation's engine sales in the Atlantic Division, has been transferred to Buffalo to succeed Mr. Barnaby. He will be assisted by J. F. Hecking, who continues in his present capacity of assistant manager of the Oil and Gas Engine Application Division.

THE DALLAS, TEXAS, District Office of Allis-Chalmers Mfg. Co., of which E. W. Burbank is manager, has been moved to a new location, 1800 North Market Street, where the Power, Electrical and Industrial Divisions of the Company now occupy an entire building. This three story building houses not only the Company's offices but also its warehouse which carries a large stock of Tex-rope belts and sheaves, transformers, motors, starters and pumps. It also has a small machine shop where minor repairs may be made.

F. C. HOUGHTEN, director of the research laboratory of the American Society of Heating and Ventilating Engineers, has been appointed chairman of a newly formed joint A. S. H. V. E.-A. S. T. M. "Committee on Conductivity" to determine national standards for the measurement of conductivity. Serving with Mr. Houghten as representatives of A. S. H. V. E. will be Professor F. B. Rowley, director, engineering experiment station, University of Minnesota and Gordon Wilkes, professor of heat-power engineering, M. I. T. The A. S. T. M. members will be H. C. Dickinson of the United States Bureau of Standards, Professor E. R. Queer, Pennsylvania State College and R. H. Heilman, research fellow, Mellon Institute, Pittsburgh. The National Research Council and the American Society of Refrigerating Engineers have been invited to appoint representatives.

THE STRAIGHT LINE FOUNDRY & MACHINE CORP., 218 South Geddes St., Syracuse, N. Y., announces that The Straight Line Engine Co., Inc., and The Direct Separator Co., Inc., have been merged to form The Straight Line Foundry & Machine Corp. The business of each will be continued as before under The Straight Line Division and The Direct Separator Division, respectively, of the new corporation.

WORTHINGTON Pump and Machinery Corp. of Harrison, New Jersey, announces the appointment of Ludwig Emde to the position of Detroit District Sales Manager. Mr. Emde has been a member of the Worthington organization since his graduation from the University of Michigan in 1930, and is well known in the Detroit district. He will succeed William J. Daly, recently transferred to the corporation's Philadelphia office as manager.

GEORGE ELLERTON, JR., formerly an official of Electric Heating Equipment Co., of Philadelphia, is now located with Faville-LeVally Corp., of Chicago, in the Steel Mill Division.

STEVENS Institute of Technology for the first time is offering during the academic year 1938-1939 a program of evening graduate courses. This program supplements the day graduate work which has been given for several years. In developing its new educational project the faculty has considered the needs and interests of graduate engineers employed in the metropolitan area. Coordinated groups of related courses are offered in the fields of mechanical engineering, electrical engineering—specializing in communication and economics of engineering.

MR. AND MRS. A. E. GIBSON, president and stockholder respectively, The Wellman Engineering Co., Cleveland, Ohio, in the presence of officials and employees of the company, were presented a check for $13,941.33 by A. F. Davis, secretary, The James F. Lincoln Arc Welding Foundation, Cleveland, as Grand Award of the Foundation's Program in which $200,000 was awarded throughout industry for scientific studies of arc welding. Judged by a jury of 31 engineering authorities, the studies showed a saving of $1,600,000,000 available to industry by wider application of the arc welding process. Mrs. Gibson holds a bachelor of science degree and master's degree in chemistry. Following the award to the Gibsons, Mr. Davis, presented a certificate in recognition of the excellence of their study to G. W. Burrell, chairman of the board of the Wellman company.

EDWARD A. SAUER, combustion engineer for the D. L. & W. Coal Co., died here after a brief illness. He was 38 years old. Mr. Sauer was born in Newark. He came to Buffalo six years ago and since that time has covered Western New York and Ontario for his employers.

National Exposition of Power

The Thirteenth National Exposition of Power and Mechanical Engineering will be held at Grand Central Palace, New York, occupying three floors, during the week of December 5 to 10, 1938. Dynamic and comprehensive displays designed to give the visitor the latest salient information in the shortest possible time will present new developments in power generation and mechanical engineering equipment.

Sectionalized models and working demonstrations of equipment will especially feature that part of the Exposition devoted to valves and fittings. One manufacturer of special steam traps promises an interesting study in thermodynamics. A complete power plant will be set up with boiler, reducing valve, load, trap, open receiver and pump, showing the trap under glass in actual operation. Many new designs in valve operations will make their debut this year. Among them will be air pilot operated valves and air operated liquid level controllers, both of whcih are said to be extremely sensitive and capable of wide range.

Among the oil filters, one working model will show carbon black being removed from oil. Air filters for specialized service in steel mills, on Diesel fuel remote pipe line pumping stations, aircraft engines, and gear case vents also will be presented. A new stainless steel bellows will be on display for the first time. The ability of all-metal pressure tubing to absorb vibration and movement while carrying liquids and gases under pressure, will be demonstrated. Other exhibits will include seamless flexible bronze tubing and vibration eliminators.

Refractories and insulation materials will be interestingly presented. Semi-metallic packings and specialty packings, some of which are specially designed to resist oil conditions where rubber heretofore has proven unsatisfactory, will be shown. Displays of insulating materials will include cement, rock wool, flax, asbestos, rubber and plastic compositions. Suspended air cooled walls, suspended arches and solid battery walls will be demonstrated by means of scale models.

Boiler room instruments and controls with working models to show methods of operation will be exhibited. Transmission devices will include V-belts, round and flat endless belts, belt fasteners, industrial hose, silent and roller chain drives, flexible couplings, variable speed units, standard and over-running clutches, speed control units, gears, sprocket wheels, speed reducers, ball and roller bearings and truck casters.

50,000 kw. More For Essex

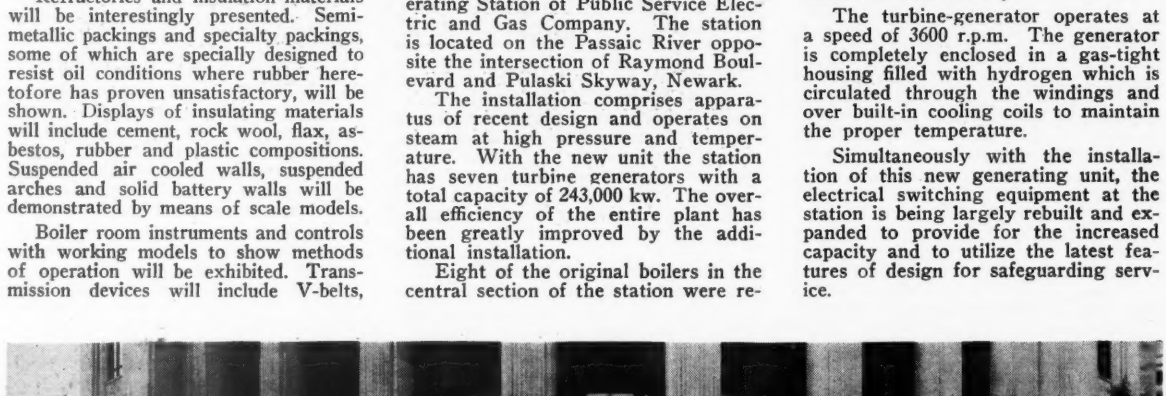
AN ADDITIONAL GENERATING unit of 50,000 kilowatt capacity has been placed in service at the Essex Generating Station of Public Service Electric and Gas Company. The station is located on the Passaic River opposite the intersection of Raymond Boulevard and Pulaski Skyway, Newark.

The installation comprises apparatus of recent design and operates on steam at high pressure and temperature. With the new unit the station has seven turbine generators with a total capacity of 243,000 kw. The overall efficiency of the entire plant has been greatly improved by the additional installation.

Eight of the original boilers in the central section of the station were removed and in their place have been installed two new boilers with the 50,000 kw. unit and all the appurtenant equipment necessary for safe and efficient operation. The two new boilers will each evaporate 300 tons of water per hour into steam at a pressure of 1250 lb. per sq. in. and a temperature of 950 deg. F. They are provided with dual firing facilities which permit the burning of either pulverized coal or fuel oil or both simultaneously. Approximately 1100 tons of coal or 4900 bbl. of fuel oil will be burned under these two boilers daily.

The turbine-generator operates at a speed of 3600 r.p.m. The generator is completely enclosed in a gas-tight housing filled with hydrogen which is circulated through the windings and over built-in cooling coils to maintain the proper temperature.

Simultaneously with the installation of this new generating unit, the electrical switching equipment at the station is being largely rebuilt and expanded to provide for the increased capacity and to utilize the latest features of design for safeguarding service.



National Association of Power Engineers at Grand Rapids

FOR THE FIRST time since 1924, Grand Rapids, Mich., self-styled "Furniture Center of the World" played host to the National Association of Power Engineers and entertained the Fifty Sixth Annual Convention of the Association during the week of Aug. 29-Sept. 2. The civic Auditorium in the center of town diagonally across the street from the Pantlind Hotel provided ideal convention and exhibition facilities which were matched by a comprehensive, smoothly running business and social program arranged by the convention committee under Chairman J. J. Wernette, chief engineer and superintendent of the local municipal water and light plant. The total registration, including 243 delegates, exceeded 1300.

The mechanical exposition with approximately 50 exhibits representing almost 100 manufacturers was officially opened on Monday morning with addresses by Exhibit Chairman Arthur Markham, plant engineer, Wolverine Brass Co., Edmund Burke, manager of Sales Division of the Crane Co. and National (N. A. P. E.) President Charles Bindrich of the Milwaukee Sewage Commission. Later in the week the National Exhibitors Association, with a membership of about 60 manufacturers, was reorganized and the following officers elected: President, Garrett Burgess of Garrett Burgess, Inc.; Vice President, William Wilson of the Roto Co.; Treasurer James McPeak of the France Packing Co.; and Secretary Bob Jones of Jenkins Bros.

Although the social program began Monday evening with the Officers Reception, the convention was not officially opened until Tuesday morning. Mayor George W. Welsh of Grand Rapids welcomed the Association to the city and H. M. Taliaferro, president of the American Seating Co., discussed the part that power has played in industry during the past century and a half. National President Bindrich, Past National President Wilds and Vice President Laufketter responded in accordance with opening session tradition after which Vice Chairman Bullis presented a new gavel to President Bindrich.

Business sessions were devoted largely to association business and to two papers, one by T. Waldo Ross, Manager of the Indianapolis Power & Light Co., on "The Value of the Power Plant to the Industry and the Value of the Engineer to the Power Plant," the other by Dr. Rettaliata and Hans Dahlstrand of Allis-Chalmers Mfg. Co. on "New Developments in Power Generating Systems."

Discussions and committee reports throughout the meetings indicated that interest in present, pending or proposed license laws is general from the Pacific to the Atlantic. Much has been done along this line but much remains to be done before the legal, political and practical problems have been solved. Among the latter are the conflicting needs and desires of various operating groups involved and some misunderstanding as to the relation of the operating and professional engineer.

On Friday morning the election of officers and selection of the next convention city proceeded with the same precision and well oiled smoothness that characterized the entire convention. Indianapolis was chosen for the next convention on the first ballot and the following national officers were elected unanimously: President, Fred C. Laufketter, Supt. Jefferson Hotel, St. Louis, Mo.; Vice President, Carl R. Daubenmire, Chief Examiner of Engineers of Ohio; Secretary, Fred W. Raven, Chicago, Ill.; Treasurer, Edw. J. Burke, Philadelphia, Pa.; Trustee for term of 5 yr. (reelected) Thomas J. Gambute, Asst. Chief Engineer, Burroughs Adding Machine Co., Detroit, Mich.; Conductor, Donald Kurtz, East Orange Water Dept., E. Orange, N. J.; John A. Prudell, Veterans Administration Facility, Wood, Wis., and H. W. Wilds, Chief Engineer and assistant building manager, New York Life Insurance Bldg., New York City. For the only office contested, that of doorkeeper, William Schurk, American Steel & Wire Co., New Haven, Conn., was elected by a large majority.

Central N. Y. Power Corp. to Build New Plant at Oswego

THE PURCHASE of the largest steam driven turbine-generator acquired by the electric utility industry since 1931 rated at 80,000 kw. or about was announced on Sept. 8 by Alfred H. Schoellkopf, president of Niagara Hudson Power Corporation. The turbine-generator will be built by the General Electric Company at its Schenectady plant, and the accompanying steam generating boiler will be built by The Babcock & Wilcox Company of New York City. The equipment will be erected in the large new steam electric station at Oswego, construction of which will be started in the immediate future by Central New York Power Corporation, a subsidiary of Niagara Hudson Power Corporation.

In announcing that the major contracts had been let and work already started on the initial equipment for the new steam electric plant, Mr. Schoellkopf stated: "The construction of the Oswego plant at this time is tangible evidence of our confidence that the industrial future of New York State will be such as to bring increased demands for our services in the years just ahead. By augmenting the other power generating sources of the System, the new plant will be an important factor in continuing to provide abundance and low-cost power to the people of the section of New York State served by Niagara Hudson companies."

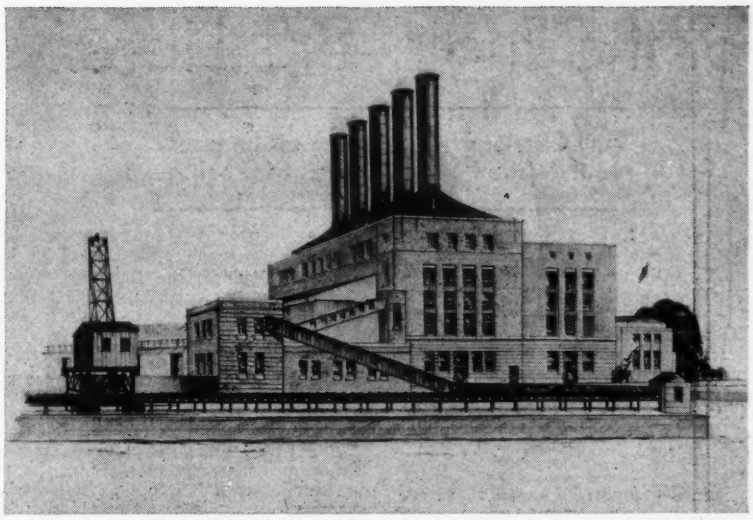
The cost involved in the construction of this new plant it is estimated will be around $9,500,000, and in terms of efficiency it is expected, the station will be one of the most efficient in the world. The design will be based on an input of 0.85 lb. of coal per kw-hr.

An important feature of the 80,000 kw. turbine is that it will be the first large 1200 lb. pressure condensing unit to be built in a single casing. The high-pressure, high temperature steam turbines constructed in recent years have in general been non-condensing machines, relatively small. Where large 1200 lb. machines were needed, the units have been of the tandem or cross compound design.

Recent advances in materials and design have made it possible to return, in the case of this new turbine, to the compact, single cylinder design and to use high pressures and temperatures with resulting high economy with a relatively small turbine operating at 1800 r.p.m. This turbine will be slightly over 53 ft. long overall, about 13 ft. in height from the floor and will weigh about 500 tons. The steam conditions will be 1250 lb. at 900 deg. F.

The generator will be a hydrogen cooled unit, generating at 13,800 v.

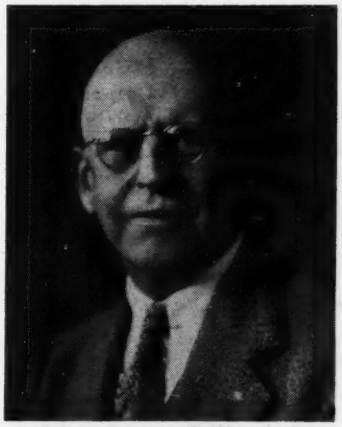
The boiler will have a steaming capacity of 850,000 lb. per hr. with a furnace volume of 36,940 cu. ft. and fired by pulverized coal. Four pulverizers will be provided each with a capacity of 12 tons per hr. and driven by 75 hp. motors. A thermal efficiency of 87.1 per cent is expected.



Jasper H. Fisher

ON AUGUST 26, Jasper H. Fisher, who for more than 25 yr. had been the active head of the Fisher Governor Co., Marshalltown, Iowa, passed away in St. Joseph's Hospital at Orange City, California, where he had been a patient since the first of last April. Funeral services were held at St. Paul's Episcopal Church, Marshalltown, and burial was in the family lot at Riverside Cemetery, this city.

Born in Marshalltown on September 6, 1878, he was the son of William Fisher, the founder of the Fisher Governor Co. Mr. Fisher was educated in the



public schools of Marshalltown and attended Iowa State College at Ames. Following that, he spent a number of years in sales work before becoming associated with the Fisher Governor Co. which he was later to build into one of the largest manufacturing concerns of its kind in the country. The organization at the time Mr. Fisher joined it consisted of only 14 people, the total now includes approximately 300. When he became associated with his father's manufacturing business, the company was making only two or three types of automatic controls. Today it is producing more than 157 separate and distinct types of various controls such as pump governors, liquid level controllers, automatic pressure regulators, gas pressure controls and steam traps. He had been a staunch supporter of many associations and groups in all the industries with which his company was connected, and he had been particularly active in various power associations.

Mr. Fisher is survived by his wife and their four children, Mrs. R. L. O'Toole, Martha Ellen Fisher, Allan Fisher and J. William Fisher.

Instrument Application

AN INSTRUMENTATION contest with a first prize of $200 in cash is announced by the Industrial Instrument Section of Scientific Apparatus Makers of America.

Twelve prizes in all, totaling $500, will be awarded by the Apparatus Makers. The contest is open to any engineer or operating man, not employed by an instrument manufacturer. Each contestant is to write about an unusual application of a standard instrument or control device, telling briefly what conditions or need impelled the application. By instrument or control device is meant any device used for measurement or control in a plant or laboratory, or any accessory used with a device for measurement and control.

The contest will be judged by the following Jury of Award — Chairman Lyman J. Briggs (Director, National Bureau of Standards) Members: M. F. Behar (Editor INSTRUMENTS), W. E. Forsythe (Physicist, Nela Park Research Dept., General Electric Co.), John J. Grebe (Director of Physical Research Laboratory, Dow Chemical Co.), R. J. S. Pigott (Head of Engineering Dept., Gulf Research & Development Co.) and Ex-officio Phil T. Sprague (Chairman, Industrial Instrument Section S. A. M. A. and President of the Hays Corp.).

The contest closes November 15, 1938 and the judging will be held during the week of December 5.

Copies of the contest rules and official entry form can be obtained from Scientific Apparatus Makers of America, 20 North Wacker Drive, R. 3014, Chicago, Ill.

For the Engineer's Library

Any Catalogs that you wish will be gladly sent. Write Power Plant Engineering.

Pumps

Centrifugal Pumps—A new bulletin describing the new line of Fig. 3390 centrifugal pumps. These pumps are two stage with opposed, hydraulically balanced impellers for heads up to 1000 ft. Bulletin gives complete description. Goulds Pumps, Inc., Seneca Falls, N. Y.

Pumps—Opposed impeller series pumps, in which two single suction impellers are mounted with the suction openings facing in opposite directions towards the end of the shaft are described in Catalog B-3. In this type of pump not only is the impeller balanced hydraulically, but only two pairs of wearing rings are needed, the same as for a single-stage pump. Leakage from the second stage to the first stage is reduced by a labyrinth shaft sleeve and the short, stiff shaft requires only small clearance. De Laval Steam Turbine Co., Trenton, N. J.

SS Unit Close Coupled Centrifugal Pump is the title of Bulletin 1653 on close-coupled centrifugal pumps covering a range of 10 g.p.m. against 10 ft. head to 1600 g.p.m. 120 ft. head, and for lower capacities up to 300 ft head. It includes capacity tables showing ratings obtainable and recommended motor sizes and speeds for various ratings. Allis-Chalmers Mfg. Co., Centrifugal Pump Division, Milwaukee, Wis.

Pumping Water for Descaling Spray is the subject of an article by H. M. Graham of the Dravo Corp. It describes a pumping station at the plant of the Youngstown Sheet & Tube Co. This 4-page, illustrated article has been reprinted by and may be had on request to the De Laval Steam Turbine Co., Trenton, N. J.

Refinery Process Pumps known as Class FH and FL and built for capacities up to 800 g.p.m. and heads to 400 ft. are described in Bulletin 2432 issued by Ingersoll-Rand Co., 11 Broadway, New York, N. Y.

Centrifugal Pumps—A new bulletin describes the new line of Fig. 3390 centrifugal pumps. These pumps are two stage with opposed, hydraulically balanced impellers for heads up to 1000 ft. Bulletin gives complete description. Goulds Pumps, Inc., Seneca Falls, N. Y.

Pumps—Bulletin 203-2 describing acid and chemical pumps covers fully the construction of this type of pump and contains many interesting cuts and illustrations. It should prove especially interesting to engineers and superintendents who are concerned with the problem of pumping acids and other corrosive liquids. The Lawrence Machine & Pump Corp., 371 Market St., Lawrence, Mass.

Pumps—The designing of centrifugal pumps to handle liquids carrying solids in suspension, such as unscreened sewage and wood pulp in paper mills, was discussed by A. Peterson, Chief Engineer of the Pump Department of the De Laval Steam Turbine Co., in a paper presented last fall before a section of the American Society of Mechanical Engineers and now made available for general distribution. De Laval Steam Turbine Co., Trenton, N. J.

Instruments

Niagara Liquid Meters is the subject of a new catalog listing Niagara hot water meters used for boiler feed measurement or condensate measurement in power plants; also Niagara cold water meters for measuring boiler make-up water and Niagara oil meters for measuring supply to oil burner equipment. Each type of Niagara meter, for cold water, for hot water or oils is a separately built and engineered product, designed throughout for accuracy measurement and long life on its intended service. Buffalo Meter Co., 2917 Main Street, Buffalo, N. Y.

Instruments and Controls—Seven pieces of literature illustrate and describe the following equipment: Round Chart Recording Potentiometer, Metameter Controller, Electric Flow Meter and Coordinated Process Control. Bristol Co., Waterbury, Conn.

Weston Industrial Temperature Gages—A 12-page booklet just published contains complete information about these new all-metal thermometers, both general purpose and heavy-duty types. Sectional views of the gages, typical scale faces and side views of several models illustrate the booklet. Specifications of general purpose as well as heavy-duty models are given, for accuracy, head design and diameters, scale lengths, ranges, connection nuts and stem lengths. Copies may be obtained by writing the Weston Electrical Instrument Corp., Newark, N. J.

Instruments—A new 64-page catalog entitled "TAG Indicating, Recording and Controlling Instruments for Temperature and Pressure" has just been published. It is more than a regular listing catalog for it presents information in a clear, understandable way on the latest TAG instrument developments. In addition to the new line of recording thermometers and recording pressure gages with 10 and 12 in. charts, complete data will be found on indicating and recording controllers. The control instruments are listed on either the "On-Off" model for all ordinary control applications, or the throttling model for use where any considerable apparatus lag is encountered. A copy of Catalog 1060D will be sent on request to C. J. Tagliabue Mfg. Co., Park and Nostrand Aves., Brooklyn, N. Y.

Internal Combustion Engines

Fuel Oil Standard CS12-38, effective for new production May 31, 1938, is now available and can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 5 cents a copy. These new standards supersede CS12-35.

Automotive Maintenance Cleaning—Modern methods for effectively handling the many necessary cleaning operations in conjunction with present-day automotive fleet maintenance and truck motor repairing are fully described and illustrated in a 36 page booklet recently released by Oakite Products, Inc., 14 Thames St., New York, N. Y.

Airless Injection four-cycle Diesel engines built in sizes from 75 to 200 hp. and 360 r.p.m. are described in a new 6-page bulletin, 238, by the Wolverine Motor Works, Inc., Bridgeport, Conn.

Diesel — Capacities, specifications and mechanical features of the largest "Caterpillar" Diesel Tractor have been grouped together in new booklet, Form 4876, just issued by the company. Printed in two colors, the book is profusely illustrated, the pictures showing action view of the Diesel D8 tractor on the job, as well as cutaway views of the engine, fuel system, transmission, final drive, etc. Copies of Form 4876 may be had by writing Caterpillar Tractor Co., Peoria, Ill.

Electrical Equipment

Relays—Bulletin 132 illustrates and describes heavy duty relays for a.c. and d.c. circuits which are available with normally open or closed contacts. The bulletin includes contact data, specifications and dimensions. Ward Leonard Electric Co., Mount Vernon, N. Y.

Lincoln Tubes—An interesting Bulletin 738 describes the electrical features of the new Lincoln Tubes which connect New York and New Jersey. This Lincoln project when fully completed will cost $90,000,000 of which $2,000,000 is accounted for in electrical equipment. This description, written by S. E. Schultz, Electrical Engineer for the Port of New York Authority is of general interest as well as of value to the electrical industry. These tunnels are the most completely equipped motor car tunnels in the world. I-T-E Circuit Breaker Co., Philadelphia, Pa.

Copperweld Telephone Lines for Overhead Communication Circuits—A new 8 page data pamphlet, E. D. 1683 presenting pertinent data of interest to the communication engineer in a power company. Issued by Copperweld Steel Co., Glassport, Pa.

Electrical Instruments—A new line of 3 in. square flush mounting panel instruments—a.c. and d.c. ammeters, milli-ammeters, micro-ammeters, and thermo-couple ammeters and voltmeters,—are announced by the Roller-Smith Co. Three are described in Supplement 3 to Catalog 48. Another new catalog, No. 9, recently issued by this company is devoted to a description of Type R-2 rotary switches for instruments and apparatus control. Roller-Smith Co., 233 Broadway, N. Y.

The Welder's Trouble Shooter—An 8-page booklet, lists the common troubles met by welders, together with the cause and cure for each. Some of the troubles mentioned are: distortion, welding stresses, cracked welds, undercut, porous welds, brittle joints and corrosion. Copies of this booklet, B.2150-A may be secured from Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Combustion Equipment

Smoke Regulation—In the 1937 annual report of Board of Health of Hudson Co., N. J., is included the report of William G. Christy, Abatement Engineer, on the work of his department with railroads, stationary plants, and steamboats, in fuel savings, smoke abatement and public education.

Anthracite Stokers are illustrated and described in a new 4-page Bulletin No. 1005. It points out nine features of the stoker and includes a table of sizes and manufacturer's ratings. Flynn & Emrich Co., Baltimore, Md.

Combustion Control—A 32-page bulletin entitled Bailey Meter Control describes the application of the Bailey steam flow-air flow automatic readjustment type of air-operated combustion control. In addition to describing and illustrating the various elements of the control system, the bulletin explains fundamental principles involved in controls, both for boilers fired with stokers and for boilers fired with fuels in suspension. Several actual installations are shown diagrammatically and illustrated with installation photos. Bailey Meter Co., Cleveland, Ohio.

Refractories—A 36-page brochure well presented to impress the reader of the importance of the refractory industry and the Laclede Christy Clay Products Co. It illustrates the personnel, offices and products and a history of the organization. Laclede Christy Clay Products Co., St. Louis, Mo.

Refractory—Bulletin 1200 illustrates and describes Vitriram, a plastic refractory ramming mix suitable for repair work on complete monolithic lining in boilers, furnaces and kilns, where the temperature does not exceed 2900 deg. F. The U. S. Stoneware Co., Akron, Ohio.

Material Handling

Wheelbarrows and Scrapers are illustrated and described in an 18-page catalog 54 which has just been issued by the Fairbanks Co., New York, N. Y.

Hoists and Trolleys—In addition to the regular Ford line of spur geared, screw and differential chain hoists, Catalog No. 38 describes several additional items such as jib cranes and differential hoists with ball bearing mountings. The new ball bearing Ford spur geared hoist is featured in the catalog. Copy will be sent on request to The Ford Chain Block Division of the American Chain & Cable Co., Inc., Philadelphia, Pa.

Miscellaneous

Economizers — Two new pages which are to be added to Bulletin 35—76 on heat economizers have just been issued by the American District Steam Co., North Tonawanda, N. Y.

Water Treatment—A new bulletin, entitled Infilco Hot-Flow Water Softeners for Boiler Feed Water Treatment, points out that water for boiler use must be more than soft. It must be clean, safe to prevent boiler metal embrittlement, and must protect the feed water system and boiler against corrosion. Copies are available on request. International Filter Co., 59 East Van Buren St., Chicago, Ill.

Mountings—A new 8-page illustrated catalog covers the company's standard line of Vibro-Insulator rubber-to-metal type mountings. This catalog does more, however, than picture the six types of Vibro-Insulators and list their dimensions. It is also prepared to serve as a practical guide for those who are not familiar with many factors involved in the selection and installation of such mountings. A copy of this catalog can be obtained by writing the Mechanical Rubber Goods Division of The B. F. Goodrich Co., Akron Ohio.

Manual of Ordinances and Requirements for Smoke Elimination, Air Pollution and Fuel Combustion. 160 pages; 6 by 9 in.; paper cover; price 50 cents. Smoke Prevention Assn., City Hall Square Bldg., Chicago, Ill.

Covering methods of measuring air pollution and smoke density, also the rating of stokers and their operation, this manual gives a model smoke abatement ordinance and methods of administering it. Tabulations are given of the requirements in some 50 cities and results attained.

Practical details are discussed in the papers presented before the Association at its 32nd Convention, with instructions for burning bituminous coal economically and smokelessly in residential and apartment building boilers.

This manual deserves a place in the library of anybody who is interested in improving furnace combustion, especially for small, low-pressure boilers.

Oil Fires Extinguished with Water

THE extinguishing of oil or other flammable liquid fires by the use of a finely divided spray of plain water has been under investigation intermittently for the past 15 yr. It is only recently, however, that this method has come into commercial use as an aid to or replacement of chemicals or gases of the non-supporting combustion type. This photograph shows an oil fire being extinguished by the use of new spraying nozzles recently developed by The Spray Engineering Co. of Somerville, Mass. These new Fire Fog Nozzles use a water spray rather than special chemicals in fighting oil fires. In operation they combine a blanketing and cooling effect in extinguishing the flames. The use of water eliminates the cost of special chemicals and prevents the supply being exhausted before the fire is put out. This equipment has been approved by the Factory Mutual Laboratories of the Assoc. Factory Mutual Fire Insurance Companies. The nozzles may be coupled directly to a hose or in conjunction with play pipes furnished in different sizes.

New Engineering Books

Engineering Terminology. By Victor J. Brown and Delmar G. Runner. Published by Gillette Publishing Co., 330 So. Wells St., Chicago, Ill. Size 6 by 9 in., 310 pp., cloth bound. Price $3.50.

Various branches of applied engineering, all of which spring from the common root of natural and physical science, have found it expedient to develop a specialized vocabulary. A word or phrase in one branch may have an entirely different meaning in another and neither may bear any marked relation to the etymological derivation. As a step toward avoiding misunderstanding and difficulty from this source for purposes of contracts, correspondence, agreements, price lists, specifications, etc., between different branches, the general public and other professions, the authors have collected 237 pages of concise definitions arranged in dictionary form. Terms from highway, geological, hydraulic and related branches of civil engineering are predominate but in spite of this the book is unique and helps fill a need of all engineers and those in the business and professional world who must deal with engineers.

Included also are engineering abbreviations, hydraulic and mechanical symbols, German-English words, Spanish-English and English-Spanish words, temperature inter-conversion tables, chemical elements and their characteristics, weights and measures, conversion factors, standard pump classifications, and materials for pumping various liquids. Each and all of these words and phrases, and the extra appendix material, have been approved by a committee of the technical society or trade association of the branch of engineering from which the word was taken or to which it applies.

Trane's Air Conditioning Manual —By William Goodman. Published by The Trane Co., La Crosse, Wis. Size 8½ by 11 in., 322 pp., cloth bound. Price $5.00.

Air conditioning has a great future in the domestic, industrial and service fields but as yet the surface has barely been scratched. There is little standardization, many points are controversial, many practices are arbitrary. Yet this whole industry is built on a solid foundation of fundamental theory so clearly, concisely and simply developed by Mr. Goodman that one cannot help but wonder how differences of opinion can arise.

The viewpoint of the book is practical. It is concerned primarily with the application of fundamental engineering theory to air conditioning in general to enable the engineer or student to reason out the problem rather than to depend on rules and formulae. The first part of the book is a review of heat as applied to air conditioning and the effect of temperature, humidity and air movement on bodily comfort. The last part of the book deals with refrigeration and water for air conditioning purposes.

These chapters are well done but Chapters III, IV and V are outstanding. Heat gains from all sources are outlined in detail, typical calculations made and cooling loads totalized on estimate sheets so that no item will be overlooked. (Six of these sheets come with the book and additional ones can be purchased separately in pads of 25 for 75 ct. per pad.) The author has developed a distinctive psychromatic chart with a special celluloid ruler which can be used to solve a variety of problems. The use of the charts and calculations for conditioned air supply are explained in great detail by a large number of worked out problems and this section of the book is in two colors, making the charts commercially effective and clear. A pad of 25 psychromatic charts and a ruler come with the book but they too may be purchased separately, 50 ct. for the ruler and 50 ct. for pads of 50 charts.

The book is so refreshingly new, comprehensive and different that no engineer with even a remote interest in air conditioning can afford to omit it from his library. The Trane Co. builds heating, cooling and air conditioning equipment and it is not unusual for a manufacturer with a background of research and application to issue books of a fundamental or practical nature for its own organization or to insure proper application of its equipment. It is unusual, however, to have such books published without advertising matter, or, without an undue amount of space boosting application of its equipment. This one has not a line of advertising, not even a list of products manufactured, only a simple 14 line foreword by Reuben N. Trane, President, expressing appreciation of Mr. Goodman's research and the work of the company's engineering and laboratory staffs in producing the manual for the industry.

Elementary Thermodynamics. By V. M. Faires. Published by The Macmillan Co., New York, N. Y. Size 6 by 9 in., 197 pp., cloth bound. Price $2.60.

Applied Thermodynamics. By V. M. Faires. Published by The Macmillan Co., New York, N. Y. Size 6 by 9 in., 366 pp., cloth bound. Price $3.90.

Problems on Applied Thermodynamics. By V. M. Faires and A. V. Brewer. Published by The Macmillan Co., New York, N. Y. Size 6 by 9 in., 137 pp., paper bound. Price $1.40.

As might be expected from the titles and author, these three books are closely related but the first two should not be considered as supplementary to each other. The first is intended as a text for a short course in thermodynamics. It has been shortened, not by a briefer treatment covering the same ground as the second more complete text but by omitting certain sections completely. Ten chapters covering some 154 pp. of the smaller book are identical in the two volumes, while the remaining three chapters covering some 40 pp. are made up of material selected from various chapters of the larger book and combined under different chapter headings.

The second volume, applied thermodynamics, may therefore be considered as the first volume plus 169 pp. of additional material. Inasmuch as this additional material deals to a large extent with the practical application of thermodynamic principles, photographs of actual machines and biographical material of interest, the first volume may be dismissed from serious consideration as far as the practicing engineer is concerned. We shall therefore consider only the second volume in detail.

This is well arranged and concisely written in clear, understandable language. Written as a college text it of course presupposes a knowledge of physics, mechanics and calculus which serve as a foundation upon which the theory and practice of thermodynamics are developed.

The book, which is the outgrowth of a lithoprinted edition issued two years earlier. is divided into 24 chapters and opens with a discussion of the general energy equation. This leads into a discussion of the characteristics and equations of gases, vapors and mixtures, cycles, combustion and heat transfer, internal combustion engines, steam engines, turbines, air compressors, refrigeration machines, complete steam plants and auxiliary apparatus.

Although the elementary volume has 338 problems incorporated in an appendix, problems for the larger book have been bound in a separate volume. This volume (Faires & Brewer, who are both professors of Mechanical Engineering at the Agricultural & Mechanical College of Texas) contains 1403 problems supplemental to the larger volume Applied Thermodynamics, and in addition 41 pages of tables including properties of saturated and superheated steam, ammonia, Freon and sulphur dioxide. In the back of the book are three charts, Mollier Diagrams for carbon dioxide and steam and a psychrometric chart for air conditioning work.

Aspects of Science. By Tobias Dantzig. First edition, 286 pages. Published by The Macmillan Co., New York, N. Y., 1937. Price $3.00.

Early in the 18th Century when the then revolutionary scientific discoveries were modishly the subject of genteel drawing room discourse, a devout old lady—at least so the story goes—who had been pursuing Laplace's "System of the World" met the great man at a social function, and at once proceeded to air her grievance: "I have been reading your book," she said, "and I am at a loss to understand how one could write such a comprehensive treatise on the universe without once mentioning its creator!" To which Laplace is supposed to have replied: "Madame, I have found no need for this hypothesis."

In one of its various forms, this little story illustrates very well the two points

of view involved in the ancient issue between science and religion which has existed from the beginning. For many years in the early life of experimental or what is today called classical science, the controversy raged bitterly, and, strangely enough, this was at a time when science had for its object, more or less, the rationalization of the world, which was precisely the idea upon which the faith of the religious apologists was also founded. Both religion and classical science postulated a Cosmic Intelligence; religion explicitly, classical science implicitly. Religion identified this Intelligence with the active principle which could be invoked in the affairs of man, for this Intelligence had the affairs of man at heart. To classical science this Intelligence was a symbol of the essential unity of the universe, a token of immutable order, a guarantee of that order.

So science and religion need never have clashed from the standpoint of their ultimate perspectives of the universe, and it was not here that they did clash. It was when they met on the battlefield of life that they clashed. They clashed because one taught an attitude toward life which was incompatible with that taught by the other. Religion counselled resignation, abandon, harmony within—science, self reliance, sober judgment, mastery of the world without.

Now, strangely enough, at the very time when, by its findings during the last quarter of a century science has been forced to abandon the naive realism of the classical period, thereby widening the cleft between those who urge harmony within and those who clamor for mastery without, the attitude of the religious apologists is changing and since 1926 when Eddington precipitated a revival of the ancient issue, in countless books, symposia, magazine essays, newspaper articles and sermons, we are being told that the chasm which has separated religious and scientific thought is about to be bridged, if it has not already been bridged.

It is against this background of changing concept and human misunderstanding that the ideas concerning science in this book are projected. The result is a picture, clear cut in its essential scientific composition, yet softened with enough of human aspirations and desires to give it satisfying perspective. It is the clear presentation of the influences that have motivated both science and religion that make this book so interesting. At a time when man's once-buoyant faith in the ultimate realities has been shaken to its depths by the crumbling, one by one, of the ideas upon which these realities were founded, there is a need for a clear, dispassionate appraisal of all the factors which influence scientific thought. For, as the author explains, science does not live by logic and experiment alone. There exists a category of ideas which are indispensible to scientific thought and yet derive their validity from neither logic nor experience. To this category of ideas belong some of the most fundamental conceptions of science; the rational character of the cosmos; inductive inference, the infinite; rigidity. uniformity and simultaneity; space, duration, etc. All these notions when analyzed turn out to be tinged with such collective predilection.

It takes a mathematician to write a book such as this and that, no doubt, is why Dr. Dantzig has succeeded so well—he is professor of mathematics at the University of Maryland. Few besides a mathematician would accept the conclusions to which one is inevitably driven in an analysis of this kind; indeed, it takes a mathematical mind to recognize the answer when one comes to it.

The book is simply and clearly written and there is practically no mathematics in it, but do not be misled by this. Do not assume that you can read this book casually. It is written for those who have the ability to understand, and who have, to begin with, something of what it takes to make a scientist. To those who can read it, we recommend it highly.

Standards for Steam Jet Ejector and Vacuum Cooling. Published by the Heat Exchange Institute, 90 West St., New York City. Size 8½ by 11 in., 37 pp. paper bound. Price $1.00.

This is a new section of the Institute's standards and is divided into three parts. Part One covers nomenclature, operating principles, types of assemblies, capacity and standard accessories and materials of construction of steam jet ejectors. Part Two is a Test Code for Steam Jet Ejectors, covering motive steam, condensing water vacuum, pressure and capacity measurements; performance tests; diagrammatic arrangements of various tests; standard air nozzle orifices and curves on steam flow and air water vapor mixture data. Part Three covers nomenclature, definitions, performance, construction, standard units and special types of steam jet vacuum refrigeration equipment.

The Tennessee Valley Authority. By Clarence Lewis Hodge. Published by The American University Press, Washington, D. C. Size 6 by 9 in., 248 pp., cloth bound. Price $3.00.

Engineering details and accomplishments of the T. V. A. have been adequately covered in the technical press while faults and limitations of the organization itself have been well aired in the daily newspapers during the congressional investigation. There is another side, however, that is little known and appreciated, the politic and economic significance of regional development into the field of government. Dr. Hodge, a Teaching Fellow in Political Science, The American University, has covered this phase in a comprehensive and entertaining manner.

Regionalism, defined by the author as the principle of administering an area unified by common social, economic, cultural and physical characteristics, is not new in theory or practice. As a world trend, however, it is recent and the T. V. A. is a full scale experiment along this line, the culmination of more than a century of development for Muscle Shoals, as a national issue, was first brought up by Secretary of War Calhoun in 1824. In a larger way the beginning of regionalism in this country goes back to 1789 when the limitations of state boundaries led to the first interstate compact authorized by Congress.

The book deals with the T. V. A. but largely as a background for regionalism. It analyzes the nature, accomplishments and failures of the T. V. A. with the idea in mind that this forms a workable pattern for future regional authorities if the American people care to use it. If regions are going to supercede states the possibilities and difficulties are foreshadowed. If regions are to be superposed on the present rigid structure of political boundaries the problems are different.

Dr. Hodge feels that regionalism is inevitable and looks at the T. V. A. sympathetically. Yet his interest in regionalism as a form of government transcends his interest in the T. V. A. itself and he analyzes the organization, its failures and successes quite critically as a practical testing ground for regional planning in its larger sense.

Principles of Motor Fuel Preparation and Application, Vol. 1, Second Edition. By Alfred W. Nash and Donald A. Howes. Published by John Wiley & Sons, New York, N. Y. Size 6 by 9½ in., cloth bound, 571 pp. Price $9.50.

Phenomenal advance of the internal combustion engine of recent years has been a guiding factor in the petroleum industry. The ever increasing demand for motor fuels has forced the development of refining methods which would yield an increased percentage of gasoline from the crude, while research and changes in engine design have brought a complete revision of fuel specifications. At the same time the question of national defense and national economies has forced research in the field of production of motor fuels from oil shale, coal and alcohol.

Rapid change has perhaps been responsible for the lack of books on this particular field and the engineering world is indeed fortunate that this task was undertaken by Messrs. Nash and Howes. The former is Professor of Petroleum Technology at the University of Birmingham, both are members of the Institution of Petroleum Technologists and in a position to treat the subject authoritatively and completely from the refiners standpoint. More important from the engineer's point of view, however, is the clear, concise and straightforward style which can be followed by the general reader interested in the practical results rather than the details of the refining process.

Because of its long length the book is divided into two volumes. Volume 1 (the first edition of which appeared in 1934. See Aug. 1935, p. 484) deals with the production of motor fuels by distillation, cracking, extraction from gas, and hydrogenation. The new edition has been brought up to date and a new chapter on pyrolysis and polymerisation added Other chapters cover the production of Benzole and synthetic fuels including alcohols.

Lightning Proof Transmission Lines. Publication No. F6, published July, 1938, by The Edison Electric Institute. Price 60c to members of the Institute and their employes, $1.50 to non-members in the U. S. A.

A 34 page booklet dealing with the theory, design, construction, reconstruction and operating experience. It constitutes a report of the transmission group of the transmission and distribution committee of the Institute.

Power Plant Construction News

Ark., Russellville—City Council has plans under way for new municipal electric power plant, estimated to cost about $320,000, with equipment. Financing will be arranged through bond issue and Federal aid.

Calif., San Francisco—Dwight Edwards Co., 255 Twelfth Street, plans installation of power equipment in new three-story coffee-roasting and blending plant at Mariposa and Arkansas Streets, for which superstructure will be placed under way this fall. Entire project will cost about $200,000. Jesse Rosenwald, 525 Market Street, is consulting engineer.

Colo., Denver—Bureau of Reclamation, Denver, will receive bids until October 10, for three 11,500-hp., Francis-type hydraulic turbines, with governors and accessories: and for three 9000-kv-a. electric generator units, with exciters, etc., for installation in Elephant Butte hydroelectric power plant, Rio Grande project, New Mexico-Texas. Also, at same time for two 15,000-hp. Francis-type hydraulic turbines, governors, etc., and for two 12,000-kv-a. electric generators, with exciters and accessories, for installation in Green Mountain hydroelectric power plant, Colorado-Big Thompson Project, Colo. (Specifications 802).

Fla., Jacksonville — United States Gypsum Co., 300 West Adams Street, Chicago, Ill., plans installation of electric power equipment in new wallboard and gypsum products mill at Jacksonville, where site is being selected on Trout River. It will consist of several units. A steam power house is planned. Entire project will cost close to $1,000,000.

Ind., Kokomo—Board of School Trustees, Kokomo, has plans under way for new central steam power house for central heating service for a number of schools. Cost estimated at $335,000, with boiler units and accessory equipment. Financing is being arranged through Federal aid. McGuire & Shook, Fletcher Trust Building, Indianapolis, Ind., are architects.

Iowa, Fort Madison—State Board of Control, State House, Des Moines, Iowa, plans new steam power plant at institution at Fort Madison. Cost over $200,000, with boilers and auxiliary equipment. Financing will be carried out in part through Federal aid.

Kan., Arkansas City—City Council plans installation of a complete water-softening plant and system for municipal waterworks. Cost estimated at about $180,000. Financing in part will be arranged through Federal aid Black & Veatch, 4706 Broadway, Kansas City, Mo., are consulting engineers.

Kan., Paola—City Council has plans under way for new municipal electric power plant, using Diesel engine-generator units and accessory equipment. Project will include electrical distributing lines. Cost about $240,000. Financing will be arranged through a Federal loan and grant. W. B. Rollins & Co., Railway Exchange Building, Kansas City, Mo., are consulting engineers.

Kan., Winfield—City Council has plans under way for expansion and improvements in municipal power plant, including installation of new 2000-kw. turbo-generator unit and accessory equipment. Cost about $175,000. Financing is being arranged through Federal aid. Black & Veatch, 4706 Broadway, Kansas City, Mo., are consulting engineers.

La., Alexandria—Louisiana Ice & Electric Co., Alexandria, has plans under way for new steam-electric generating plant on local site. Cost over $400,000, with turbo-generator units and auxiliary equipment. Proposed to begin work soon.

La., Bossier City—Arkansas Fuel Oil Co., plans installation of power equipment in connection with expansion and improvements in local Loreco oil refining plant. Also installation of other mechanical equipment, storage tanks, pumping machinery, etc. Entire project will cost over $900,000.

Mich., Charlevoix — City Council plans extensions and improvements in municipal electric power plant, with installation of additional equipment. Cost estimated close to $125,000. Financing is being carried out through Federal aid. Hamilton & Weeber, Grand Rapids, Mich., are consulting engineers.

Mich., Coldwater — State Department of Public Buildings, Lansing, Mich., plans new steam-electric power plant for institution at Coldwater, including electrical distributing lines. Cost about $325,000. E. R. Little Co., Inc., Ford Building, Detroit, Mich., is consulting engineer.

Mich., Flint—Buick Motor Division, General Motors Corporation, Flint, plans installation of electric power equipment in new two-story addition to automobile plant, 310x750 ft. Cost over $500,000. Albert Kahn, Inc., New Center Building, Detroit, Mich., is architect and engineer. Work will be placed under way soon.

Mich., Kalamazoo — Sutherland Paper Co., plans installation of electric power equipment in new addition to mill for production of paperboard specialties. Cost estimated about $170,000. L. W. Sutherland is president.

Minn., Stewartville — Common Council is considering plans for new municipal electric power plant. Cost estimated close to $120,000. Financing is being arranged through Federal aid. Burlingame, Hitchcock & Estabrook, Inc., Sexton Building, Minneapolis, Minn., is consulting engineer.

N. J., Toms River—Dover Township Committee, Toms River, is considering new municipal electric light and power plant Cost estimated close to $500,000. Project will be on ballot for approval of citizens at general election in November.

N. Y., Binghamton—International Business Machines Corporation, 590 Madison Avenue, New York, N. Y., plans installation of electric power equipment in new addition to plant, three-story, 160x450 ft. Entire project will cost close to $550,000. Proposed to begin work this fall.

N. Y., Syracuse—Church & Dwight Co., 1416 Willis Avenue, and Solvay Process Co., Solvay, Syracuse, plan installation of electric power equipment in new plant on Willis Avenue for production of bicarbonate of soda and allied chemical specialties. Entire project will cost over $2,000,000. Contract has been let to the Austin Co., 16112 Euclid Avenue, Cleveland, Ohio, engineer and contractor, for design and erection of buildings.

N. C., Charlotte—Hudson Silk Hosiery Co., North Brevard Street, plans installation of electric power equipment in new addition to knitting mill for large increased capacity. Entire project will cost close to $1,000,000. An air-conditioning system will be installed. E. Seifart is president and treasurer.

Ohio, Amherst—Village Council has engaged Floyd G. Browne, Marion, Ohio, consulting engineer, to make surveys and estimates of cost for proposed municipal electric power plant and waterworks station. Financing will be arranged through Federal aid. Conrad Zilch is president of Board of Public Affairs.

Ohio, Cleveland—Weldrods Corporation, recently organized subsidairy of Air Reduction Co., 60 East Forty-second Street, New York, plans installation of power equipment in new one-story plant at Cleveland, for production of welding rods and wire, etc. Proposed to begin work soon. Entire project is reported to cost close to $100,000.

Ohio, Middletown—City Council is projecting plans for new municipal electric power plant, estimated to cost about $2,400,000. Financing will be carried out through Federal aid. Froelich & Emery Engineering Co., Second National Bank Building, Toledo, Ohio, is consulting engineer.

S. C., Orangeburg — Orangeburg-Aiken Hydro-Electric Commission, Orangeburg, James M. Green, chairman, plans new hydroelectric generating plant on the Edisto River, near Orangeburg. Cost about $1,500,000 with power dam, power house, transmission lines and other structures. Financing is being arranged through Federal aid. Daniel T. Duncan, Ninety-Six, S C., is consulting engineer.

Texas, Goose Creek—City Council has plans maturing for new municipal electric power plant, estimated to cost over $150,000. Financing will be carried out through Federal aid. Garrett Engineering Co., 308 Hughes Street, Houston, Tex., consulting engineer, will make surveys and detailed estimates of cost.

Texas, Odessa—Barnsdall Refining Corporation, Tulsa, Okla., plans installation of power equipment in connection with proposed rebuilding of gasoline refinery at Odessa, recently destroyed by fire. Loss estimated over $200,000, including equipment. Company engineering department will be in charge.

Va., Lexington—City Council has preliminary plans for new municipal electric power plant, including distributing system. Cost close to $365,000, to be financed through Federal loan and grant.

W. Va., Eagle—Eagle Collieries, Inc., Charlestown, W. Va., plans new coal tipple on Kanawha River, Eagle, including conveyor system, loaders and other mechanical equipment. Cost reported over $50,000. Application has been made for Federal permission.